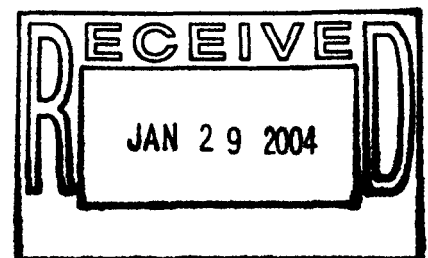


**OU4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

**U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, CO**



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EXECUTIVE SUMMARY

This Final Field Program Report (FFPR) presents the results of a ground water investigation conducted for Operable Unit 4 (OU4) at the U S Department of Energy (DOE) Rocky Flats Environmental Technology Site (RFETS) in Jefferson County, Colorado. Operable Unit 4 is also commonly referred to as the Solar Evaporation Ponds (SEPs) Operable Unit. This work was completed in partial fulfillment of the Phase II RFI/RI Work Plan (Work Plan) for OU4 at RFETS (EG&G, 1994a). The Phase II RFI/RI is being conducted pursuant to the Interagency Agreement (IAG) among the DOE, the U S Environmental Protection Agency (USEPA), and the Colorado Department of Public Health and Environment (CDPHE). The IAG program addresses both RCRA and CERCLA regulatory frameworks, although the IAG designates OU4 as a RCRA-lead site.

Although the Phase II RFI/RI Work Plan identifies characterization activities related to ground water, surface water, and soil, this FFPR and the field activities leading up to its development relate only to the characterization and understanding of the ground water system in the vicinity of OU4. In this respect, the FFPR was developed to integrate historic ground water data with data generated during the latest ground water field investigation for the purpose of developing an integrated interpretation of all available ground water data from OU4. Consistent with the Phase II RFI/RI Work Plan, the FFPR is intended to provide information required for the development of a corrective measures study (CMS) for ground water at OU4 and identify associated data gaps with respect to the CMS. A complete understanding of the ground water system hydraulics and the nature and extent of contamination is necessary for the analysis of potential corrective measures.

Prior to the initiation of the latest field program, available data regarding the ground water system at OU4 and in the vicinity of OU4 were compiled and reviewed. Based on this review, a study area was identified that extends beyond the limits of OU4. This was done to facilitate a complete understanding of the ground water chemistry and hydraulics of OU4 as well as the areas hydraulically upgradient, sidegradient, and downgradient of OU4. This extended study area allows for the OU4 ground water system to be evaluated and understood in context with the adjacent areas, making the selection, construction, and implementation of future corrective measures more efficient and effective.

To ensure that the interpretation of this complex ground water system was not unintentionally oversimplified, and therefore perhaps misunderstood, the basic nomenclature for the ground water hydrostratigraphic units at the site was modified for the FFPR. Prior to the FFPR, the two important hydrostratigraphic

units, known as the Upper Hydrostratigraphic Unit (UHSU) and the Lower Hydrostratigraphic Unit (LHSU) were recognized at OU4 and throughout RFETS. For the purposes of the FFPR, the UHSU has been divided into "Unit 1" and "Unit 2," and the LHSU has been designated "Unit 3." The UHSU is defined as the surficial unconsolidated alluvial and colluvial sediments and the underlying weathered or fractured portion of the uppermost claystone bedrock unit. The upper unconsolidated deposits of the UHSU are designated as Unit 1 throughout this document. The underlying weathered or fractured portion of the UHSU is designated as Unit 2. The LHSU underlies Unit 2 and includes the unweathered or unfractured portion of the claystone bedrock. The LHSU is designated as Unit 3 in this document. Therefore, Unit 1, Unit 2, and Unit 3 represent the three hydrostratigraphic units that are present at OU4, in order of increasing depth.

In general, ground water in Units 1 and 2 flows laterally from the west-southwest toward the SEPs. From beneath the SEPs, Unit 1 and 2 ground water flows eastward and diverges to the east-southeast and north-northeast toward the South and North Walnut Creek drainages, respectively. It is believed that these surface water drainage features act as a hydraulic divide for the Unit 1 ground water, however, this understanding is uncertain or unknown with respect to Units 2 and 3. Local variations in the ground water flow patterns in Unit 1 and 2 are present, however, justifying the separation of these units during the data review and characterization phases of the RFI/RI. Ground water flow patterns in Unit 3 are virtually unknown except that the regional ground water flow gradient is surmised to be eastward in this area, based on the location of RFETS in the Denver structural/hydrostratigraphic basin. A complete understanding of the lateral and vertical ground water flow patterns with respect to Units 1, 2, and 3, is critical to understanding the nature, extent, fate, and transport of ground water contaminants at OU4.

Following the review of existing data, an investigative strategy involving the observational approach and real-time ground water characterization methodologies was developed to accelerate the supplemental characterization of the ground water system at OU4. This strategy involved the use of surface geophysical methods to successfully identify the locations of potential preferential pathways in the subsurface and the subsequent implementation of a ground water sampling program using a geoprobeTM rig and real-time analysis of samples in a field laboratory. As these new data were generated, they were integrated with existing data throughout the investigative process.

Ground water contaminants of concern at OU4 include nitrate, volatile organic compounds (VOCs), metals, and radionuclides. The geoprobeTM investigation was successful in delineating the 10 milligram per liter (mg/L) nitrate contour in ground water in Units 1 and 2 throughout most of the study area. The 10 mg/L value, reported as nitrogen, is the Federal Maximum Contaminant Level for

nitrate Based on the current data, including transport characteristics of nitrate and the rate of ground water flow, it is evident that nitrate contamination is more extensive than VOC, metal and radionuclide contamination Chemical and subsurface data indicate that the VOC, metal, and radionuclide plumes originating from OU4 are contained within the extent of the 10 mg/L nitrate plume

Although metals have been identified as contaminants of potential concern at OU4, they are not mapped out or otherwise addressed in this report The extent in ground water of "elevated" metals concentrations (i.e., concentrations of metals which are considered to be outside the range of natural background) is limited to a very small area immediately beneath the SEPs

The emphasis of this report is to provide a graphical representation of the unified data set for OU4 The report was developed to synthesize and interpret all existing geophysical and ground water data in a clear and consistent manner A series of maps are presented using a common scale and standardized terminology to summarize the integrated data sets Document text is provided to support these graphics, to clarify our understanding of the contaminant fate and transport issues, and to elucidate remaining data uncertainties In addition, the data synthesized prior to initiation of the supplementary field investigation are also provided Again, these data are represented graphically and supported by text

Many of the data gaps identified in the Phase II RFI/RI Work Plan were filled as a result of the field investigation efforts However, due to schedule constraints and other circumstances beyond the control of the project team, some appreciable data gaps still remain These remaining data gaps must be filled before a conceptual remedial design can be completed in a CMS

The primary recommended data requirements pertaining to our understanding of the extent, fate, and transport of contaminants in the OU4 Study Area are as follows

- Further definition of the extent of the nitrate plume in North and South Walnut Creek drainages
- Development of a complete and valid understanding of the vertical hydraulic relationships between Units 1 and 2 as well as between Units 2 and 3
- Development of a complete and valid understanding of the vertical extent(s) of the contaminant plumes
- Additional information concerning the potential north-south trending fault which may coincide with one of the primary flow pathways
- Completion of the lateral and vertical quantification of all "target" volatile organic compounds in ground water (based on an analysis of historic data)

Revisions are recommended in this report for the current ground water data collection program at OU4 and vicinity to (1) focus on efforts that support the technical understanding of ground water quality and hydraulics in this area, and (2) provide the data needed to move toward and complete the CMS. Specifically, it is recommended that an analysis of the treatment goals or action levels be conducted with respect to radionuclides to focus future characterization efforts on the appropriate constituents in the appropriate locations. More detail regarding these recommendations is provided in the document.

An extensive site characterization and corrective action program has been ongoing at the Rocky Flats Environmental Technology Site (RFETS) Operable Unit 4 (OU4). OU4 is comprised of the former Solar Evaporation Ponds (SEPs) and surrounding areas. Activities to date have been conducted under a hybrid RCRA and CERCLA program pursuant to the 1991 Interagency Agreement (IAG). Phase I of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) was completed to address the sources of contamination at OU4 (i.e., the ponds) and adjacent soils. Phase II of the RFI/RI is required by the IAG to focus on the nature and extent of contamination resulting from releases of hazardous and radioactive constituents from the SEPs to ground water and surface water. This report was prepared to support the OU4 Phase II RFI/RI and subsequent corrective action program.

1.1

OBJECTIVES OF THE OU4 PHASE II RFI/RI

The Phase II RFI/RI is being conducted pursuant to the 1991 IAG. The administrative process is different from other operable units at RFETS since OU4 is undergoing closure under RCRA interim status. The IAG specifies that the Phase II RFI/RI is required to focus on the nature and extent of contamination resulting from releases of hazardous substances from the OU4 interim closure unit. The principle objectives identified for the Phase II RFI/RI are:

- Determine if contamination resulting from releases from the SEPs to ground water and surface water is sufficient to warrant a Corrective Measures Study/Feasibility Study (CMS/FS), and
- Provide necessary information for the development of a CMS/FS and identify additional pre-design data requirements.

A large quantity of data have been collected on the nature and extent of ground water contamination at OU4 pursuant to the sitewide RCRA monitoring program. The bulk of these data were presented in the Phase II RFI/RI Work Plan, along with additional proposed hydrogeologic and geochemical characterization activities. During the preparation and completion of the Phase II Work Plan, however, it was recognized that the quantity of data available for ground water at OU4 was almost sufficient to complete the objectives laid out above. A major factor leading to this realization was the conclusion that a CMS/FS for ground water at OU4 would be necessary based on existing data. Hence, an effort was undertaken to list the data needs for performing the CMS/FS, and to identify data gaps which would need to be filled prior to initiating the CMS/FS study.

The Phase II Work Plan was subsequently modified to allow for the implementation of an "Observational Approach" to filling data gaps for the CMS/FS study. The purpose of the observational approach is to incrementally fill data gaps using field analyses and real-time investigation techniques. As more data gaps are filled, the remaining data gaps are evaluated and refined to avoid collecting unneeded data. The initial phase of the observational approach included a real-time field investigation of ground water using a geoprobeTM and field analytical instruments to determine the extent of ground water contamination, and to complete the conceptual model of ground water occurrence and movement. This report describes this real-time field investigation and presents an integrated data summary including all historical and new information.

1.2

PURPOSE AND ORGANIZATION OF REPORT

The purpose of this report is to present the results of the recent real-time field investigation and to provide an integrated data summary including recommendations for additional data related to the corrective action program for ground water at OU4.

The real-time field investigation presented in this report accomplished several of the data collection goals laid out in the Phase II Work Plan. However, due to changes in the management operations, and funding at RFETS, the study was terminated prematurely. Several of the data gaps identified at OU4 have been filled, but many still remain open. The presentation of an integrated data set as laid out in this report is unprecedented for OU4, and significant effort has been expended to ensure that each map is internally consistent with all other maps in this report. It is intended that this report will serve as the final record for the Phase II investigation of ground water at OU4 until activities are restarted.

This Final Field Program Report (FFPR) provides a summary of existing data (Section 1.3), describes the observational approach methodology used at OU4 (Section 2.0), presents the results of the real-time field investigation using the observational approach (Section 3.0), presents conclusions based on an integrated data evaluation (Section 4.0) and provides recommendations and additional data requirements that may be required to complete a Corrective Measures Study (CMS) for ground water at OU4 (Section 5.0). Figure 1 shows the OU4 site including the eight study areas developed for this field investigation.

This report is structured to provide a graphical representation of the unified data set for OU4. The report was developed to synthesize and interpret all existing geophysical and ground water data in a clear and consistent manner. A series of maps are presented using a common scale and standardized terminology to summarize the integrated data sets. Document text is provided to support these

graphics, to clarify our understanding of the contaminant fate and transport issues, and to elucidate remaining data uncertainties

The report is organized to allow the reader to review data from historical and the most recent investigations separately, and also to provide a section summarizing information synthesized from the combined set of investigations. A summary of historical data prior to this field investigation is presented in Section 1.3. The results of the field investigation are presented in Section 3.0. The combined data analysis based on historical and recent investigations is presented in Section 4.0.

Selected data from the Rocky Flats Environmental Database System (RFEDS) and other sources were used in conjunction with data obtained from this investigation to develop an up-to-date evaluation of current hydrogeologic conditions and determine the nature and extent of ground water contamination at OU4. Sections 4.2 and 4.3 of this report describe the current understanding of ground water flow conditions and ground water contamination at OU4 based on an evaluation of the integrated data sets.

In order to complete a CMS that effectively addresses ground water contamination at OU4, additional hydraulic and chemical data are required. These additional data requirements are detailed in Section 5.0 along with specific recommendations for data collection.

1.3 SUMMARY OF HISTORICAL DATA

This section discusses the understanding of subsurface conditions at OU4 prior to the most recent "real-time" field investigation. Much of the data are provided in various reports (see References) and in RFEDS. A comprehensive understanding of ground water at the site has been developed through a detailed review, and in many cases, reinterpretation of the data.

Data related to the geology/hydrogeology and ground water flow in Sections 1.3.1 and 1.3.2 respectively. A discussion of geophysics and ground water contamination based on historical data is provided in Sections 1.3.3 and 1.3.4, respectively. Note that the information summarized in Section 1.3 is presented primarily as a factual reference regarding the historical database at OU4. The hypotheses, conclusions, and recommendations developed in this field investigation are presented in Sections 3, 4, and 5.

1.3.1 Geology/Hydrogeology

Two important hydrogeologic units are present in OU4, designated the Upper Hydrostratigraphic Unit (UHSU) and Lower Hydrostratigraphic Unit (LHSU). The UHSU is composed of two separate layers which have very different

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composition and flow characteristics. The upper layer of the UHSU includes the unconsolidated alluvial and colluvial deposits and has been designated as "Unit 1". The lower layer of the UHSU consists predominantly of the weathered or fractured portion of the uppermost claystone bedrock unit along with some lenticular sandstone deposits and has been designated as "Unit 2". (The sandstone deposits are considered part of Unit 2 where they are present within the unweathered or unfractured portion of the bedrock unit and where they are in hydraulic connection with either the weathered/fractured bedrock or the unconsolidated deposits). The LHSU, located beneath Unit 2, consists predominately of unfractured and unweathered claystones, and has been designated as "Unit 3". Figure 2 presents an isopach map (thickness) of Unit 1. Figure 3 shows subcropping lithofacies for the OU4 site.

Lithologic information derived from monitoring wells, piezometers and soil borings completed during previous investigations has been used to develop the current description of the surface and subsurface geology at OU4. Operable Unit 4 is located at the edge of a Rocky Flats Alluvium pediment surface. Streams have incised the Rocky Flats Alluvium both north and south of OU4, creating topographic relief on the order of 50 to 100 feet. This relief has a major influence on shallow ground water flow patterns and gradients at OU4.

Representative cross sections were prepared that illustrate the relationship between the various surface and bedrock lithologic units present at OU4 (Figures 4, 5, and 6). The location of the three cross sections are shown on Figure 1. The cross sections graphically illustrate the hydrostratigraphic relationship of Unit 1, Unit 2, and Unit 3, the projected ground water elevations within the units (September 1994 and May/June 1995), and the presence of the collection pipe for the Interceptor Trench System (ITS). Note that the vertical exaggeration on the cross sections is 10:1. Also, the data upon which the ITS collector pipe elevations are based is relatively uncertain. No "as-built" drawings were prepared for the ITS, the locations presented on the cross-sections were extrapolated from available manhole invert elevations.

Ground water elevation maps were generated for both Unit 1 and Unit 2 using data collected as part of an ongoing quarterly ground water monitoring program. The September 1994 data are the most comprehensive set of water-level data available and provide the basis for much of the following interpretation. Figures 7 and 8 show the ground water elevation maps for Units 1 and 2, respectively, based on the September 1994 RFEDS data. The relevant RFEDS ground water elevation data is presented in Appendix A.

1.3.2

Ground Water Flow

Ground water laterally flows into OU4 from the west-southwest in Units 1 and 2. Ground water flows eastward beneath the SEPs and diverges to the east-southeast.

toward South Walnut Creek and to the north-northeast toward North Walnut Creek. Ground water diverges in this area due to an east-west trending bedrock high beneath the SEPs and natural topographic breaks in these directions.

Although Units 1 and 2 are comprised of unconsolidated deposits and weathered bedrock, respectively, ground water does not flow homogeneously through these units. In some areas where Unit 2 (weathered bedrock) is relatively competent, ground water flows primarily in Unit 1 (unconsolidated deposits). Conversely, where Unit 2 is highly fractured, ground water can preferentially flow in Unit 2. The flow paths are complex because of the highly variable primary and secondary permeabilities of Units 1 and 2.

The understanding of lateral flow hydraulics combined with an understanding of the vertical potentials between Units 1 and 2 and between Units 2 and 3 helps to simplify the complex flow patterns within these units. Figure 9 indicates that the vertical hydraulic potentials are downward between Units 1 and 2 and between Units 2 and 3 in the vicinity of the SEPs. However, the vertical hydraulic potential may be upward in the vicinity of the South and North Walnut Creek drainage areas. This pattern of vertical potentials, combined with an understanding of lateral hydraulic relationships, suggests that as ground water laterally diverges in the vicinity of the SEPs it also moves (or has the potential to move) downward. As the ground water migrates closer to the drainage area, it may circulate upward due to vertical potentials. This relationship (based on September 1994 ground water elevation data) is illustrated on Figure 9. With respect to fate and transport of contamination in ground water, a clear understanding of vertical potentials is essential to determine, (1) if contaminated ground water is likely to migrate into deeper hydrostratigraphic units (i.e., Unit 3), and (2) if contamination is likely to cross the hydraulic boundaries of South and North Walnut Creeks. The lack of a conclusive assessment of the vertical potentials at OU4 represents a significant data gap.

Ground water flow in Unit 1 and Unit 2 is predominately to the east across the terrace and north and south off the slopes of the terrace toward the streams. Because the saturated interval of Unit 1 is often very thin, seasonal fluctuations in ground water elevations result in large areas of the unit becoming unsaturated. In addition, the ITS dewateres large portions of Unit 1 on the north slope of the OU4 terrace. Lateral ground water flow direction in Unit 3 is not well defined. As stated above, vertical potentials between Unit 3 and Unit 2 are also poorly understood.

The hydraulic conductivity of Unit 1 is typically two to three orders of magnitude greater than that of Unit 2. The hydraulic conductivity of Unit 2 is in turn one to two orders of magnitude greater than that of Unit 3. Based on this information, horizontal flow within Unit 1, and to a lesser extent Unit 2, dominates the flow system within OU4. However, localized fracturing and the presence of bedrock

sandstone lenses may provide preferential ground water flow pathways for contaminant migration between hydrostratigraphic units (EG&G, 1994a)

The analysis of hydrogeologic characteristics of Unit 1 includes the following observations (see Figure 7)

- The September 1994 ground water elevation map for Unit 1 indicates that the ground water potentiometric surface generally mimics the surface topography of the site (Figure 5) Ground water flow is from west to east across the terrace that the SEPs rest on, and toward the surface drainage areas of North and South Walnut Creek off the slopes of the terrace
- The Unit 1 aquifer exists under unconfined conditions throughout OU4
- Horizontal hydraulic gradients calculated from the September 1994 data range from as low as 0.01 feet/foot (ft/ft) in the vicinity of the SEPs to as high as 0.12 ft/ft along the slopes north of the SEPs
- Vertical hydraulic potentials between Unit 1 and Unit 2 are generally downward in the vicinity of the SEPs (Figure 9)
- Unsaturated conditions are present in Unit 1 over large portions of the site Some of the unsaturated conditions are attributable to the dewatering effects of the ITS, operating north of the SEPs However, unsaturated areas south and east of the SEPs are not significantly effected by the ITS Seasonal variations also effect unsaturated conditions in Unit 1
- The saturated interval in Unit 1 is relatively thin across much of the area (0 to 5 feet), especially along the topographic highs, and in slope areas where thin deposits of alluvium/colluvium are present Along portions of North and South Walnut Creek within the study area, the saturated thickness of Unit 1 can be as much as 10 feet
- Based on limited data, North and South Walnut Creek appear to act as ground water divides for Unit 1
- Hydraulic conductivity values in Unit 1 have been reported from a number of sources and range from 10^{-8} to 10^{-2} cm/sec (3.0×10^{-1} to 3.0×10^2 feet/day (ft/d)) with the higher values attributed to valley fill and alluvium, and the lower values attributed to the Rocky Flats Alluvium (EG&G, 1994) The typical hydraulic conductivity for Rocky Flats Alluvium was on the order of 10^{-5} cm/sec (3.0×10^{-1} ft/d) No data were cited for the hydraulic conductivity of fill material at OU4
- Data from piezometers P207689 and P209789, east of the 207-B Ponds, and Well 43993, between 207-B Ponds and 207-A Pond indicate that ground water in Unit 1 may be perched in those areas

The analysis of hydrogeologic characteristics of Unit 2 resulted in the following observations (see Figure 8)

- The bedrock units below Unit 1 consist of claystone and silty claystones with sandy siltstones and some intercalated lenticular sandstone bodies. Claystone is the predominant subcropping lithology in Unit 2, but the smaller subcrops of siltstone and sandstone may be present. Lithologic variation within these units may control ground water flow at OU4.
- Overall, ground water flow directions in Unit 2 are very similar to those in Unit 1. There are, however, no large unsaturated areas that disrupt ground water flow patterns in Unit 2. These unsaturated areas change ground water flow directions in Unit 1, locally (see Figure 6). Flow is generally eastward beneath the SEPs between North and South Walnut Creeks, and north and south into their respective drainage areas.
- Horizontal hydraulic gradients for Unit 2 are highest along the slopes north of the SEPs with values as high as 0.11 ft/ft. Horizontal hydraulic gradients for Unit 2 are lowest in the area immediately east of the SEPs (EG&G, 1994b). The lower gradients may be the result of relatively lower hydraulic conductivities in that area.
- Hydraulic conductivity values in Unit 2 range from as high as 10^{-5} cm/sec (3.0×10^{-1} ft/d) for sandstone units to as low as 10^{-7} cm/sec (3.0×10^{-3} ft/d) for weathered claystone (EG&G, 1994a).
- The data presented on Figures 6 and 8 show the topographic and hydraulic gradients converging at South Walnut Creek, indicating that a ground water divide exists within Unit 2 at South Walnut Creek. Although the topographic gradient would suggest a similar divide at North Walnut Creek, insufficient data exist to define the hydraulic gradient on the north side of the creek and thereby define a ground water divide for Unit 2.
- Unit 2 exists under unconfined conditions throughout most of OU4. However, confining conditions may be present in some localized areas, most noticeably in the areas where it appears that lower gradients exist, such as around Wells 5774 and 5093 (Figures 7 and 8). The lower gradients may be the result of a zone of lower relative hydraulic conductivity near the top of Unit 2 which could also account for confined conditions.
- Secondary permeability within Unit 2 was created by weathering and fracturing of the upper portion of the claystone bedrock. Some of the fracturing is thought to be caused by a high-angle reverse fault which trends north-south across OU4. This fault was based on evidence seen in geophysical borehole logs in deep wells, a zone of intense fracturing observed within two wells, and a trench that was constructed specifically to investigate the faulting.

The analysis of hydrogeologic characteristics of Unit 3 resulted in the following observations

- Wells screened in Unit 3 showed large fluctuations in water levels from one quarter to the next, and the magnitude and direction of the fluctuations were inconsistent for different wells (This may be the result of poor well construction highly variable recovery rates following purging, dramatic variations in permeabilities, or any combination of these)
- The number of wells and piezometers drilled into and screened in Unit 3 is very limited, and therefore did not allow for adequate geologic and hydrologic characterization
- Boring logs completed for most of the well and piezometers that penetrated Unit 3 did not indicate that saturated conditions were encountered during drilling
- Hydraulic conductivity values for Unit 3 ranged from 10^{-7} to 10^{-9} cm/sec (3.0×10^{-3} to 3.0×10^{-5} ft/d) for claystones and 10^{-5} or 10^{-6} cm/sec (3.0×10^{-1} to 3.0×10^{-2} ft/d) for the sandstone subcrops (EG&G, 1994a)

1.3.3

Geophysics

Geophysical data available prior to the initiation of the Phase II RFI/RI field work include borehole geophysical logs, ground penetrating radar (GPR), and seismic refraction. Borehole geophysical logging was performed in two boreholes, 42193 and 44193, which are located in and near SEP 207 A, respectively. The borehole geophysical logs run in these wells included natural gamma, neutron, and induction. GPR was used to identify utilities and other piping around the SEPs.

In May 1993, Hadley and Hollingsworth performed a p-wave refraction seismic survey. This study is referred to as the Phase I seismic evaluation and consisted of a total of seven lines. Five of the seven lines in the study were located near the SEPs and within the Protected Area (PA). Lines 6 and 7 were located in the Buffer Zone (BZ) to the north of the perimeter access road. These data were collected to define the topography of the top of the Unit 2, particularly to identify paleochannels which could serve as preferential ground water flow pathways. Additional details of the data acquisition and processing of these data can be found in the OU4 IM/IRA report (EG&G, 1994b).

Previously existing geophysical data which characterize Unit 3 are limited to borehole geophysical logs recorded for Wells 42193 and 44193, located in and near SEP 207A, respectively. These logs defined a zone of decreased porosity within the silty claystone bedrock which is interpreted to be Unit 3. This type of geophysical log is a more accurate method for defining the Unit 2/3 interface than visual inspection of the degree of fracturing present in physical core samples.

The p-wave refraction seismic survey performed during Phase I could not be used to define the interface between the Unit 2 and Unit 3. P-wave velocities for the saturated portion of Unit 2 are significantly greater than for the unsaturated areas of Unit 2, however the contrast is significantly less between the saturated Unit 2 and Unit 3. If the velocity contrast is not significant between two layers it is more difficult to distinguish their interface, unless the intermediate layer is of considerable thickness. In the case of OU4, the saturated zone within Unit 2 is relatively thin, thereby masking the Unit 2/3 interface.

1.3.4

Ground Water Chemistry

The nature of the contaminants present in OU4 is well defined based on historical data. In general, three categories of contaminants have been identified in wells screened in Unit 1 and Unit 2 including inorganic constituents (most notably nitrate), chlorinated volatile organic compounds (VOCs), and radionuclides. Nitrate, VOC, and radionuclide contaminants are discussed below.

1.3.4.1

Nitrate

Nitrate was of primary interest because the compound is considered a good indicator of the extent of contaminant migration from the SEPs due to its mobility in ground water and historical presence in the SEPs. Nitrate contamination, for purposes of this analysis, is considered anything above the State of Colorado Basic Ground water Standard Maximum Contaminant Level (MCL) for nitrate of 10 mg/L (reported as nitrogen). Results of the analysis of nitrate ground water contamination at OU4 based on September 1994 RFEDS data is presented below. The relevant RFEDS nitrate data is presented in Appendix B, Section 1.

- A map of the ground water nitrate plume in Unit 1, developed from the September 1994 RFEDS data, is illustrated in Figure 10. The highest concentrations of nitrate are present in the vicinity of the SEPs and north of the ITS near North Walnut Creek. The distribution of the plume and direction of ground water flow suggest that the source of the nitrate was the SEPs, and that the plume has migrated at least 1000 feet north-northeast from that area.
- The highest nitrate concentrations exist both upgradient and downgradient of the ITS indicating that there is either a migration pathway through the ITS or that the nitrate had already moved past the ITS prior to its construction. Potential pathways for nitrate to migrate across the area of the ITS include movement through Unit 2, or movement through Unit 1 in areas where the ITS is not keyed into Unit 2 (bedrock).
- Delineation of the Unit 1 nitrate plume is relatively complete with the exception of the area north of North Walnut Creek. Plume migration has been predominantly to the north-northeast but there are no direct data to

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assess if the plume has moved north of the creek, or if all ground water in Unit 1 discharges into the creek

- Unsaturated areas within Unit 1 south and east of the SEPs may affect migration of the nitrate plume in those directions
- The ground water nitrate plume in Unit 2, illustrated in Figure 11, was developed from the September 1994 RFEDS data. The highest ground water nitrate concentrations in Unit 2 were located in the area immediately north of the SEPs
- Southeastward migration of the plume is much farther in Unit 2 than in Unit 1, reaching at least as far as South Walnut Creek. The Unit 2 nitrate plume is not adequately delineated in this direction
- The Unit 2 nitrate plume extends at least 1300 feet northeast of the SEPs. This portion of the Unit 2 nitrate plume is not adequately delineated
- Unit 2 nitrate concentrations along North Walnut Creek, immediately north of the ITS are generally lower than those observed in Unit 1
- One well screened in Unit 3 recorded a nitrate concentration greater than 10 mg/L

Comparison of the nitrate plumes in Unit 1 and Unit 2 illustrates several key points. Although the range of concentrations are relatively similar between the two plumes, the distribution is significantly different. In Unit 1, the highest concentrations are located directly beneath the SEPs and extend toward North Walnut Creek. In Unit 2, the highest concentrations are present slightly north of the SEPs and appear to be more localized.

1 3 4 2

Volatile Organic Compounds

VOCs detected in ground water above their MCLs during more than one quarterly sampling round (based on RFEDS data from 4th quarter 1993 through 3rd quarter 1994) were evaluated with respect to extent of contamination. The list of VOCs that were evaluated include trichloroethylene (TCE), tetrachloroethylene (PCE), carbon tetrachloride (CCl₄), 1,1-dichloroethylene (1,1-DCE) and chloroform. Results of the analysis of VOC contamination at OU4 is presented below.

- The map of ground water VOC plumes in Unit 1, constructed from 4th quarter 1993 through 3rd quarter 1994 RFEDS data, is illustrated in Figure 12. The contours shown on the figure are the MCLs for each of the VOCs detected in Unit 1 at concentrations above their respective MCLs. (VOCs detected at concentrations below their MCL were not included in the analysis.)
- Concentration versus time plots were developed for the five VOCs based on 4th quarter 1993 through 3rd quarter 1994 RFEDS data. These plots are

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provided in Appendix C. The plots demonstrate the limited variation in concentrations over time and considering seasonal fluctuations.

- The VOC plumes do not appear to have migrated an appreciable distance beyond the SEPs. However, delineation of the plumes to the west and the north is incomplete, based on the available data.
- Figure 13 presents the ground water VOC plumes in Unit 2 constructed from 4th quarter 1993 through 3rd quarter 1994 RFEDS data. The contours shown on the figure are the MCLs for each of the VOCs detected in Unit 2 at concentrations above their respective MCLs.
- The lateral extent of the Unit 2 VOC plumes are similar to those in Unit 1. However, the maximum concentrations in Unit 2 are one to two orders of magnitude greater than in Unit 1.
- The magnitude of the maximum VOC concentrations is indicative of the possible presence of a dense non-aqueous phase liquid (DNAPL) in ground water. The maximum concentration of carbon tetrachloride reported from 4th quarter 1993 through 3rd quarter 1994 was 13 mg/L. The solubility of carbon tetrachloride in water is reported as approximately 800 mg/L at 20 °C. In general, a concentration in ground water approaching 10% of the solubility limit is a good indicator of possible DNAPL presence. In this case, the maximum reported concentration in ground water is approximately 2% of the solubility limit. While this does not provide strong evidence of a DNAPL, it raises the possibility and warrants further investigation.
- The extent of the VOC plumes along the western edge of OU4 is not defined.
- VOCs have been detected in the upper reaches of South Walnut Creek.
- No VOCs were detected in wells screened in Unit 3.

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Radionuclides

Several radionuclides have been detected in ground water at OU4 that exceed the Colorado State standards (Table 1). Based on a review of the RFEDS data, the following radionuclides were evaluated: gross alpha, gross beta, uranium-233/234, uranium-235, uranium-238, plutonium-239/240, radium-226, strontium-89/90, total radiocesium, and tritium. Data for the uranium isotopes, gross alpha, and gross beta showed evidence of concentration gradients. Data for the remaining radioactive constituents was more sporadic and did not indicate any obvious trends to establish concentration gradients.

Therefore, gross alpha, gross beta, and the uranium isotopes were evaluated further. Contour maps were not developed for radionuclides because of the paucity and uncertainty associated with these data. Figures 14 and 15 were developed based on 1st quarter 1995 RFEDS data. The relevant RFEDS data for these radionuclides is

presented in Appendix D Results of the radionuclide analyses are summarized below

- The highest concentrations of gross alpha, gross beta, and uranium in Unit 1 were present below the 207-B ponds (Figure 14)
- Figure 14 indicates that the lateral extent of the contamination in Unit 1 appears to be confined to an area within a few hundred feet to the south, east, and west of the SEPs The plumes to the north and northeast of the SEPs requires further definition, especially in the areas of the ITS and North Walnut Creek
- The highest concentrations of gross alpha, gross beta and uranium in Unit 2 were present below the 207-B and C ponds (Figure 15)
- The Unit 2 radionuclide contamination is laterally more extensive than in Unit 1 Radioactive contamination to the north and northeast of the SEPs requires further definition, especially in the areas of the ITS and North Walnut Creek The maximum concentrations in Unit 2 are slightly higher than in Unit 1 (Figures 14 and 15)
- No radiological isotopes were detected in Unit 3 wells which exceeded their respective Colorado standards listed in Table 1

When comparing the data detailed in Figures 14 and 15 with the nitrate contour maps (Figures 10 and 11), it is noted that nearly all the radionuclide analyses reported at concentrations above the State standards (Table 1) fall within the 10 mg/L nitrate contour This observation was a critical consideration in the development of the "observational approach" strategy discussed in the following section Conclusions based on this observation are discussed further in Section 4.3.3

OVERVIEW OF THE OBSERVATIONAL APPROACH

The purpose of the observational approach "technique" is to improve the efficiency with which field characterization data are collected and evaluated to accelerate the remedial investigation process. The data collection effort is made more efficient by the implementation of a progressive and flexible application of a series of interdependent technical data collection and evaluation techniques conducted in "real time."

In general, the techniques applied as part of the observational approach progress from reconnaissance-level toward a detailed level. Each phase in the approach focuses the scope of the subsequent phase. For example, surface seismic techniques were applied as part of the observational approach at OU4 to cover large areas quickly with the objective of focusing subsequent investigative approaches on areas where preferential flow pathways were likely to be present. The components of the observational approach are designed to eliminate unnecessary work efforts while progressively filling the data requirements.

Following the interpretation of existing data, the first step undertaken as part of the observational approach at OU4 was to divide the site into multiple areas to focus the investigation. A total of eight areas were defined for the study (Figure 1). These areas are discussed individually in Section 2.3 along with their associated data requirements. Data requirements were identified for each study area based on the understanding of ground water system hydraulics and chemistry.

The next phase in the observational approach strategy included a geophysical investigation with the objective of identifying continuous lows in the Unit 2 and Unit 3 surfaces. In general, seismic lines were oriented perpendicular to the direction of ground water flow to meet the objective. Some of the seismic lines were also located to focus the investigation on potential Dense Non-Aqueous Phase Liquid (DNAPL) hydrocarbons.

The final phase in the observational approach strategy at OU4 involved the installation of geoprobeTM sample points (GSP) and the collection and analysis of ground water samples for selected constituents. These samples were analyzed in "real time" in the field using a nitrate probe and portable gas chromatograph.

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2.2

METHODOLOGY

2.2.1

Data Review and Analysis

The starting point for development of an observational approach strategy is the evaluation of all existing data pertaining to the ground water system. During strategy development, all existing available data, including but not limited to the Annual RCRA Ground water Monitoring Reports, the RFEDS, and the ground water portions of the Phase II Work Plan, were assimilated to form the basic understanding of the ground water hydrogeology and chemistry at OU4. Information was also obtained from other non-published documents provided by EG&G personnel.

The data review indicated several inconsistencies related to interpretations of existing subsurface conditions including primary ground water flow pathways and geologic flow barriers. Therefore, a critical step in the early stages of the development of the observational approach was to conduct a complete and comprehensive data review to address these "inconsistencies", to establish an appropriate set of baseline conditions, and to identify data gaps.

The data analysis phase provided a current base of information from which to begin developing the strategy for the subsequent geophysical survey and GSP study. Data evaluation efforts focused on the synthesis of information to form the basis for the selection of locations for the placement of additional geophysical survey lines, the definition of study areas (discussed in Section 2.3), the prioritization of the study areas for investigation, and the initial GSP locations.

Some of the key data requirements identified prior to the recent investigation included the following:

- Preferential flow paths and barriers to flow
- Ground water flow and chemical transport properties of Units 1 and 2
- An understanding of vertical hydraulic interactions between Units 1/2 and Units 2/3
- The nature and extent of nitrate, VOC, and radionuclide contamination

2.2.2

Geophysics

Following the review of existing data, a seismic refraction survey was conducted to identify potential preferential flow pathways and other potential subsurface anomalies which could significantly impact ground water flow. The results of this survey were in turn used to refine the geoprobeTM locations.

The existing data evaluation established the locations for the Phase II seismic lines and provided control points for this investigation. Information from the

Phase I geophysical survey and other documents were used to determine the locations which would offer the best possible information regarding the surfaces of Units 2 and 3. The majority of the Phase II lines were located in the vicinity of the ITS and in the northeast and southeast portions of the site. These areas required the most information because they are in the region of the primary flow paths.

The seismic refraction survey was conducted to provide information on the topography of the top of Unit 2 and Unit 3. Both compression or p-wave and shear wave data were collected. Both types of surveys can identify a velocity contrast due to a lithologic change, however since shear waves cannot be propagated in water, shear waves cannot identify the water table. Use of both types of waves allows for complimentary interpretations with the p-wave being used to identify the top of Unit 2 and the water table, and the shear wave being used to identify the top of Unit 2 and the top of Unit 3.

In addition to identifying primary flow pathways, the seismic survey can play a critical role in identifying paleohighs and paleolows which can serve as preferential pathways and areas of converging flow for dissolved contaminants and potential DNAPLs. Some of the seismic lines were specifically located to obtain information on potential DNAPL hydrocarbons. Since separate phase hydrocarbons that are denser than water can migrate toward and accumulate in the low areas on the bedrock surface, it was important to identify the locations of prominent bedrock depressions (specifically in Unit 2 and possibly Unit 3) in areas where high concentrations of dissolved chlorinated hydrocarbons had been detected to focus subsequent investigative efforts.

2.2.3

GeoprobeTM Investigation

The major component of the observational approach is the subsurface sampling point installation field program using a hydraulic-push probing device, or geoprobeTM. The geoprobeTM was used to penetrate the subsurface to desired depths in an effort to track contaminant levels in ground water in "real time". Analytical methods used during the investigation included an OrionTM test method for nitrate (using an ion-specific probe) and a portable gas chromatograph for VOC analysis. Information obtained from the investigation was continuously updated and re-interpreted to develop a current "map" of contamination in ground water. The results of the geophysics were interpreted and geological structures were identified that helped to focus the geoprobeTM sample point (GSP) investigation on areas with the potential for preferential ground water flow.

The key premise focusing the GSP investigation was that the VOC and radionuclide plumes originating from the SEPs were contained within the nitrate plume of concern (10 mg/L MCL contour). The purpose of the field investigation presented herein was to fill data gaps relevant to a CMS for ground water at OU4.

Due to the typically low yield and limited available drawdown in Units 1 and 2 at RFETS, a corrective measure consisting of active ground water extraction within the source area was considered infeasible. The most likely approach to remediation of ground water at OU4 was considered to be passive collection and treatment at the downgradient edges of the plume(s). Therefore, the primary data needs for the CMS relate to the locations of the most downgradient points where ground water collection might be required. Although the general nature of contamination within the other plumes is important, the exact configuration of each plume within the capture zone is not required.

Based on historic ground water quality data collected from OU4, it is evident that the distribution of nitrate is more extensive than that of the VOCs and radionuclides. This is consistent with the transport characteristics of nitrate (i.e., it moves at essentially the same rate as ground water) versus VOCs and radionuclides, which tend to travel at a slower velocity in ground water due to adsorption to the aquifer material. Furthermore, the shape of the nitrate plume reflects the primary flow pathways along which all of the other SEP-related contaminants will move. Therefore, the nitrate plume serves as a good indicator of the hydraulics of the ground water system and the locations for potential future ground water collection systems.

Based on this premise, the ultimate objective of the GSP investigation was to delineate the lateral extent of the 10 mg/L nitrate plumes in areas where data were sparse or non-existent. A secondary objective of the GSP investigation was to identify the VOC plumes and attempt to determine if they are derived from non-SEP sources.

A GSP rig was mobilized to facilitate the collection of water-level and water-quality data at selected locations in order to define the nitrate and VOC contaminant plumes. The initial GSPs for each of the eight Study Areas were installed as control points in the vicinity of existing RCRA monitoring wells. The purpose of these initial locations was to evaluate and optimize the GSP data collection techniques by comparison with available RCRA data to establish a high level of confidence in the qualitative investigative method.

Once confidence in the investigative technique had been established, the GSP program proceeded in four possible directions, upgradient, downgradient, and the two cross-gradient directions. This strategy was intended to progressively define the extent of nitrate and VOC contamination above MCLs. The determination of which direction is upgradient, cross-gradient, and downgradient is based on ground water flow direction and the evolving understanding of the hydrology at OU4 as the investigation proceeded. Subsequent sampling locations were selected based on the professional judgment of the field team using all available data.

Defining the vertical contaminant extent was limited by constraints imposed by the geoprobeTM rig. The maximum depth of GSP installation was limited by refusal at between 20 to 25 feet below ground surface. In addition, sampling was not allowed in areas where the ground surface was paved or within some areas in the vicinity of the PA. The presence of buildings and underground utilities also limited potential GSP areas. It should be emphasized that the GSP process does not generate soil cuttings.

Ground water samples were collected during the investigation by inserting a Teflon[®] tube inside the GSP, plugging the upper end of the tube, and removing the tube containing the water sample. Samples were collected in replicate, as sample volume permitted, and both primary and replicate samples (when available) were analyzed.

2.2.4 *Chemical Analyses*

Nitrate was selected as the indicator compound for the entire site, while supplemental analyses were conducted selectively for VOCs. Analyses were performed for selected VOCs in specific areas during the GSP investigation to estimate the potential contribution of non-SEP sources. Based on existing data, there were predetermined areas where sampling for select VOCs was determined appropriate. Where boundaries of the VOC plumes were suspected to extend into areas of nitrate contamination, samples were collected and screened for both nitrate and VOC parameters.

As discussed in Section 1.3.4.2, five target VOCs were identified for the GSP field program based on a review of RFEDS data from 4th quarter 1993 through the 3rd quarter 1994. The samples were analyzed for VOCs using a Photovac 10S50 portable gas chromatograph. Nitrate concentrations were determined using the OrionTM test kit and ion-specific probe. The protocol for determining VOC and nitrate concentrations was developed to meet EPA Level III standards.

2.3 *DATA REQUIREMENTS FOR STUDY AREAS*

The OU4 Study Areas, numbered only for the purpose of identification, are detailed in Figure 1. The Study Area identification numbers in Figure 1 do not necessarily represent the sequence of area priority classifications. Nor are the limits of the Study Areas restricted to the OU4 boundary (Figure 1). In addition, the locations of the GSPs were not necessarily restricted to the limits of the Study Areas. As the investigation progressed, some GSPs were needed outside of the areas. Seismic data from the Phase II geophysical survey were also used for the evaluation of data requirements for each Study Area. The specific data requirements for each Study Area are summarized below.

Study Area 1

Study Area 1 is located along the north side of North Walnut Creek extending from a point due north of the 207-A pond eastward to the area around the A-1 pond. GSPs were targeted within this Study Area to verify that ground water in Units 1 and 2 is flowing southeastward toward North Walnut Creek. This information was used to establish the lateral hydraulic limits of contaminant migration north of the SEPs. Nitrate data were also required at these locations to establish the downgradient extent of the nitrate plume along the north side of the North Walnut Creek drainage.

Study Area 2

Study Area 2 is located along the south side of the North Walnut Creek drainage with an extent approximating that of Study Area 1. GSP sites within this Study Area were intended to delineate the downgradient extent of nitrate above the 10 mg/L contour and to evaluate the vertical hydraulic gradient between Units 1 and 2.

Study Area 3

At the time of the observational approach strategy development, it was assumed that South Walnut Creek acts as a hydraulic barrier to southeastward plume migration from the SEPs. Study Area 3 is located southeast of the 207-B ponds, within the PA, and extends to South Walnut Creek. GSP locations within Study Area 3 were installed to delineate the southern extent of the nitrate plumes in Units 1 and 2.

Study Area 4

Study Area 4 is located immediately downgradient from the northernmost extent of the ITS. GSP locations in and adjacent to this Study Area are designed to evaluate the effectiveness of the ITS in cutting off ground water flow in Unit 1, and to determine if ground water contamination is migrating beneath the ITS in Units 1 or 2. Because of the existing VOC and nitrate concentrations in ground water in the vicinity of the SEPs and our understanding of the lateral ground water flow patterns in this area, both nitrate and VOCs were target compounds in this area.

Study Area 5

Study Area 5 is located between North Walnut Creek and the outer (northern) fence of the PA in the area north of ponds 207-A and 207-C. GSP locations in Study Area 5 are designed to provide data to delineate the northwestern extent of the nitrate and VOC ground water plumes in Units 1 and 2.

Study Area 6

Study Area 6 is located upgradient of Study Area 5 and is within the PA. GSPs were located within this area to determine if the subcropping sandstone unit within Unit 2 is acting as a preferential ground water flow pathway for VOCs, and to evaluate the potential for DNAPLs within subcropping Unit 2 sandstone located immediately north of pond 207-C (see Figure 3)

Study Area 7

Study Area 7 includes pond 207-C and is also located within the PA in the northeast portion of the industrial area. GSPs were located within this area to collect ground water elevation and water quality data to determine if there is a potential upgradient source for VOCs in the vicinity of pond 207-C. An evaluation of the existing data suggest that elevated nitrate concentrations may also be present in this area, therefore, both nitrate and VOCs were target data sets.

Study Area 8

Study Area 8 is located east of the SEPs, outside the PA, and east of the northeast-trending surface drainage that slopes from the northeast corner of OU4 into North Walnut Creek. Adequate data were not available from the existing data set to determine the western extent of the nitrate plume in Unit 2 within this Study Area. Several Unit 2 monitoring wells exist in this area that were not sampled for nitrate during the recent comprehensive nitrate sampling survey conducted in September 1994. If feasible, the plan was to sample existing wells in this study area for nitrate, and then if necessary, install GSPs for collection of additional nitrate data. GSPs would probably be installed in Unit 2 and may be installed in Unit 1, depending upon the results of investigative efforts in areas upgradient from Study Area 8.

3.0

RESULTS OF THE OBSERVATIONAL APPROACH GROUND WATER INVESTIGATION

3.1

RESULTS OF THE GEOPHYSICS STUDY

Since the Phase I seismic data were gathered with a 10-foot geophone spacing as opposed to the 5-foot spacing used for the Phase II data, three lithologic layers were identified in Phase I compared with four in Phase II. Four layers were identified on both the p- and the s-wave data sets. For the p-wave data, the layers with increasing depth from the surface, correspond to topsoil, Unit 1, Unit 2, and the water table. With increasing depth from surface for the s-wave data the layers correspond to topsoil, Unit 1, Unit 2, and Unit 3.

Due to excessive interference from surface features (roads, fences) and subsurface utilities, the data obtained from Lines I and J was not of sufficient quality to include in the results of the study. All other geophysical lines yielded data of adequate quality for inclusion.

Both the Phase II seismic interpretations and a re-interpretation of the Phase I seismic data were used to define the surface of Unit 2 (Figure 16). All available boring logs and the Phase I and II p-wave seismic data were combined to yield the structure contour map of the top of Unit 2 (Figure 17). A number of linear, topographically low features were identified on this map as paleochannels. The seismic shear wave investigation was performed to delineate potential preferential flow pathways at the top of Unit 3. The resulting interpretation of these data is presented as a structure contour map of the top of Unit 3 (Figure 18).

The paleohighs and paleolows for Unit 2 and Unit 3 based on the interpreted seismic and borehole log data are presented as Figure 19. By combining the results of the p-wave and shear wave surveys preferential flow pathways can be identified both within Unit 1 and Unit 2. A representative portion of these linear features were evaluated as possible ground water contaminant flow pathways during the GSP investigation.

In addition, the results of the seismic data indicate that the path of present day North Walnut Creek has been and continues to migrate northward. The current location of North Walnut Creek is located north of a linear depression in Unit 2 and this depression is also located north of a low in Unit 3. In addition to these data, field observations indicated abundant slumping of the hillside on the north side of North Walnut Creek. This slumping is consistent with the interpretation that North Walnut Creek is cutting into the north hillside.

3.2.1***Ground water Elevations***

Data from the GSP investigation are summarized in Table 2. Ground water elevations for Unit 1 and Unit 2 were determined from data collected from 77 of the 108 GSPs advanced during the recent field program. Thirty-one of the 108 GSPs installed remained dry through the collection of June 1995 water level data. Figures 18 and 19 show the ground water elevation contours for Units 1 and 2 based on GSP and RFEDS data collected from RCRA well and piezometers during May and June of 1995. Figures 20 and 21 indicate a overall rise in ground water potentiometric surfaces from September 1994 (Figures 7 and 8).

GSPs did not produce measurable levels of ground water in the northern portion of Study Area 1 north of North Walnut Creek where the ground water elevations are below the GSP installation depth limitation of between 20 to 25 feet below ground surface. Smearing of the GSP walls on installation into the high-percentage clay colluvium deposits of Unit 1 may have delayed ground water infiltration into the GSPs in Study Area 2 along the southern bank of North Walnut Creek.

A diverging lateral ground water flow is evident from the evaluation of May and June 1995 water level data as it is in the September 1994 data. In general, the results of the GSP investigation did not indicate significant differences in the hydrological trends described in Section 1.3.2, but greater definition did result from these activities.

3.2.2***Comparison of GSP and RCRA Nitrate Data***

A comparison of the nitrate concentration results from 11 GSP locations with nitrate concentrations from nearby RCRA wells is provided in Table 3. The data in Table 3 compare the 2nd quarter 1995 RFEDS data with the GSP nitrate data. Most of these pairs were within 40 percent and all GSP/RCRA well nitrate pairs showed concentrations within an order of magnitude.

Although there is no pre-determined standard for this type of comparison, the study team felt that a 40 percent variation represent excellent correlation between the GSP and RCRA data. As a reference point, one may examine the specification for precision (defined as the relative percent difference between laboratory analyses of each half of a split sample) in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP, EG&G, 1991). GRRASP requires that split analyses of a single sample should not exceed a relative percent difference of 30%. Judging by this standard, a 40% difference between samples taken from adjacent wells at slightly different times and analyzed using different analytical techniques represents excellent correlation.

Three GSP/well pairs that were not as comparable are GP22295/2286, GP24995/P209589, and GP25995/1786. While the nitrate concentrations from these GSP/well pairs were within an order of magnitude, the large differences may have been attributable to the difference between the field and laboratory analytical method, the different effective completion intervals, and/or the time of sampling. Completion intervals for GP22295/2286, P24995/P209589, and GP25995/1786 are 1-12/2 5-11 4, 3-11/8 1-19 8, and 1-8/2 5-14 feet below land surface, respectively. The sampling times between GSP/well pairs differed by up to two months.

The measurement of nitrate concentrations using the GSP-field method was found to be fast and practical for characterization efforts at OU4. The GSP-field method was used to generate "practical" concentration contours with intervals of an order of magnitude (i.e., 10, 100, and 1,000 mg/L nitrate). This contour interval adequately illustrates the lateral nitrate concentration trends without unnecessary clutter (as would be the case with a linear-based contour interval). Also, as Figures 22 and 23 illustrate, the GSP-field method was developed to maintain the spatial continuity of integrated data set for both RCRA wells and GSPs for Units 1 and 2. Finally, the GSP-field method does not generate any investigation derived waste.

3 2 3

Nitrate

Figures 22 and 23 illustrate isoconcentration contours for nitrate in ground water from Units 1 and 2, respectively. Nitrate data presented on these figures were collected from existing RCRA wells in January through April 1995 and from GSPs installed in April and May 1995. Many of the GSPs were not sampled because of inadequate water or schedule constraints due to circumstances beyond the control of the project team (these GSPs are designated "NA" on Figures 22 and 23). Nitrate data was obtained for ground water samples collected from 71 of the 108 GSPs installed during the current field program (Table 3). Eighteen of the 71 samples showed nitrate concentrations at levels above the 10 mg/L MCL.

As illustrated in Figure 22, nitrate has migrated in the direction of ground water flow in Unit 1, predominantly to the northeast and southeast toward North and South Walnut Creeks, respectively. As a result of the downward vertical potentials between Units 1 and 2, the nitrate in Unit 1 has migrated into Unit 2 over the entire extent of Unit 1. Figures 22 and 23 show that the concentrations of nitrate in Unit 2 exceed those in Unit 1 in areas within the center of the plumes.

Nitrate concentrations from seven Unit 3 RCRA wells are also posted on Figure 23, however these values are not contoured because of the low spatial density of these data points. Concentrations in these Unit 3 wells range from 0.01 to 5.93 mg/L.

3.2.4

Volatile Organic Compounds

Only two of the five target VOCs (TCE and PCE) discussed in Section 1 3 4 2 were analyzed during the GSP field investigation. Due to circumstances beyond the control of the project team, GSP data for the three additional target VOCs (including 1,1-DCE, CCl₄, and chloroform) was not collected.

A total of twenty-five GSPs were analyzed for TCE and PCE. Only two of the GSPs showed positive detections for TCE, and both of these GSPs were located within the limits of the TCE plumes shown on Figures 12 and 13. No positive detections were noted for PCE. Data for GSPs located outside the VOC plumes depicted on these figures did not indicate the presence of these compounds. In addition, several 'unknown' VOCs were detected in GSPs located within the limits of the VOC plumes shown on the figures. These 'unknown' compounds may have been one or more of the other three target compounds.

It should also be noted that the sampling protocols used during the GSP investigation were not conducted in such a manner to prevent sampling bias. Agitation associated with the ground water sampling method used may have introduced a negative bias for VOC concentrations due to the loss of lighter mass volatile compounds. In addition, sample preparation for VOC analysis consisted of pouring the sample into a clean vial via a graduated cylinder. This sample transfer method from an initial vial, to a graduated cylinder, and then into a second vial, exposes the sample to open air and increases the potential for the loss of lighter mass volatile compounds.

As stated previously in Section 1 3 4 2, Figures 12 and 13 show the five VOCs which exceeded their respective MCLs in Units 1 and 2, respectively, based on historical data only. The GSP data collected was not sufficient to provide any additional conclusive information regarding the levels of VOCs present in the areas of concern, however the GSP data did support the general trends indicated by the historical data. As illustrated in Figure 12, VOCs in Unit 1 above the constituent-specific MCLs are located adjacent to the SEPs. Figure 13 shows higher concentrations in Unit 2 relative to Unit 1, and the highest concentrations in the vicinity of 207-C pond.

With the exception of possible VOCs in ground water located upgradient from OU4, the spatial distribution of VOCs originating from the SEPs at concentrations above MCLs is contained within the extent of the 10 mg/L nitrate contours for Units 1 and 2 (Figures 10, 11, 22, and 23).

3 2.5

Radionuclides

As discussed in Section 1 3 4 3, the data for the ten radionuclides collected during the first quarter of 1995 are posted on Figures 14 and 15 for Units 1 and 2,

respectively. The figures were developed using RCRA well data from RFEDS. This data is provided in Appendix D. Due to circumstances beyond the control of the project team, radionuclide data was not collected during the GSP investigation.

The data posted in Figures 14 and 15 were compared with the spatial distributions of nitrate in ground water (Figures 10, 11, 22, and 23). It can be generalized that the lateral and vertical extent of the radionuclide concentrations of concern are contained within the lateral and vertical extent of the nitrate plumes in Units 1 and 2.

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4.1

OTHER SOURCES

According to the Historical Release Report (HRR), numerous incidents occurred upgradient of the SEPs which may have contributed to ground water contamination at OU4. These incidents are detailed in the HRR and include Individual Hazardous Substance Sites (IHSS) 150 1 through 150 7. In addition, a french drain cited in the HRR as located north of Building 776 may have been a source of radioactive contamination from incidents at Building 776.

Potential upgradient sources of carbon tetrachloride ground water contamination include IHSS 118 1, a 5,000-gallon underground carbon tetrachloride tank located adjacent to the west side of Building 730. Several releases have been documented related to this tank and its associated piping including those in 1970, 1976, and 1981.

A 5,000-gallon aboveground carbon tetrachloride tank located north of Building 707 (IHSS 118 2) is also reported to have ruptured in 1981 releasing an unknown amount of carbon tetrachloride onto the ground surface. In addition, the RCRA 3004(u) report states that there were a number of organic solvent tanks located inside the south end of Building 776 which overflowed in the 1970s. Large quantities of TCE were used to clean and prepare the concrete floors of Building 771 in the 1950's.

In 1981, a process waste tank located east of Building 774 overflowed spilling between 50 and 500 gallons of wastewater high in nitrate, plutonium, and uranium (IHSS 124 1, 124 2, and 124 3). In 1971, a process waste line from Building 774 to Building 995 that was known to have leaked previously was discovered to be leaking by a pressure test (IHSS 127). Six former underground process waste tanks and process waste lines located east of Building 774 are known to have released contaminated wastewater (IHSS 146 1 through 146 6) which may have drained into a boggy area known as Bowman's Pond.

4.2

PATHWAYS AND INFLUENCES

4.2.1

Preferential Ground water Flow Pathways

Ground water flow in OU4 is generally away from the topographically high ridges and toward the present day drainage areas of North and South Walnut Creek. The extensions of the contaminant plumes to the northeast and southeast in Unit 2 are

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probably the result of preferential pathways. Since preferential ground water flow paths can have dramatic influences upon system hydraulics, the identification and delineation of preferential flow paths (as well as ground water flow barriers) is as critical as the lateral and vertical head relationships of ground water systems. At the present time, several possible preferential ground water flow paths have been identified at OU4. Naturally occurring preferential flow paths may include the following:

- paleochannels in the Unit 2 and Unit 3 surfaces that may or may not be filled with relatively permeable unconsolidated deposits (the paleochannels in the upper surface of Unit 2 and Unit 3 indicate historical surface water flow pathways, which continue to serve as preferential flow pathways for ground water),
- a fault system which has been tentatively identified as running north-south through the SEP area
- relatively high primary permeability in Unit 2 (i.e., hydraulically continuous siltstone and/or sandstone lenses in the claystone),
- relatively high secondary permeability in Unit 2 (i.e., hydraulically continuous fissures and fractures in the claystone bedrock), and
- contaminants from the SEPs may be migrating to North Walnut Creek entirely within Unit 1, passing beneath the ITS in areas where that collection system is not keyed into bedrock

The zones within the hydrostratigraphic units which have the greatest primary permeability are more likely to serve as preferential flow pathways. For example, the sandstone lenses within the unweathered bedrock which are considered part of Unit 2 conduct fluid more readily than do claystone portions of that formation. The difference in material characteristics and fracturing between Units 2 and 3 is the basis for considering Unit 3 to generally be a less conductive layer.

Anthropogenic activities also influence ground water hydraulics. Some examples which may be relevant to OU4 include the following:

- areas in OU4 where artificial fill has been placed beneath the current ground water table could facilitate or inhibit ground water flow,
- contaminants may also be moving from Unit 1 into Unit 2, passing under the ITS, and then moving back into Unit 1 in the vicinity of North Walnut Creek, and
- underground utilities and associated gravel/backfill envelopes (i.e., trenching) in contact with or beneath the water table may create additional preferential flow paths and influence flow directions

The ITS may facilitate ground water flow as a preferential pathway and probably influences flow directions. Because all of the ground water entering and

migrating through the system is not necessarily collected, the system has the potential to facilitate contaminate migration as a preferential flow pathway. This is possible when system drain pipes pass through upgradient saturated zones and into downgradient unsaturated zones where collected water can be released from the system.

The fault trace observed by EG&G as running north-south through the SEP area may act as a significant preferential flow pathway. At the time of publication of this report, it is not known whether the fault is open and transmissive, or cemented and non-transmissive, exactly where the fault is located and how it dips, or whether there is significant displacement associated with the fault. Since the fault intersects ground water flow at a relatively steep angle, it could serve as a major ground water flow conduit if it is open and transmissive. If this is true, then the fault may be capable of transmitting contaminated water from OU4 across the North Walnut Creek drainage. The fault may also serve as a conduit for ground water at OU4 to move downward to deeper zones. These issues remain as significant data gaps to be addressed prior to selecting a corrective measure for OU4 ground water.

Portions of buildings below grade can influence ground water flow by diverting the flow around their structures and by creating drawdown through sump and drain tile recovery. These influences are likely occurring in the vicinity of Building 991 located to the southeast of the SEPs. Ground water elevation contours generated from May/June 1995 data for Unit 1 (Figure 20) suggest the presence of Building 991 imparts a zone of influence on the Unit 1 potentiometric surface.

As with lateral and vertical head relationships, a clear understanding of the nature, extent, and influences of significant preferential flow pathways or barriers to ground water flow is essential to understanding the system well enough to design an effective and efficient ground water remediation system.

4.2.2 *Artificial Stresses on the Ground water Flow System*

At this time, no known artificial stresses are being placed on the shallow or deep ground water systems in OU4, however, this requires further evaluation and confirmation. Since artificial stresses have direct implications upon system hydraulics, it must be ruled out or accounted for in the understanding of system hydraulics.

4.2.3 *Surface Water Pathways*

A major surface drainage that flows northeast from the SEPs toward North Walnut Creek may be a migration pathway. Surface water in North and South Walnut Creek provides a potential pathway for rapid off-site migration of

contaminants from OU4. Limited data indicate that nitrates and radionuclides are not present at concentrations that are above surface water standards. (Standards for North and South Walnut Creek are equivalent to the State ground water standards listed in Table 1.)

4.3

NATURE AND EXTENT OF CONTAMINATION

As discussed above in Section 2.2.3, the VOC and radionuclide plumes originating from the SEPs were assumed to be contained within the nitrate plume of concern (10 mg/L MCL). Data presented on Figures 12-15, 22 and 23 indicate that VOC or radionuclide concentrations of concern are not likely to be present outside the 10 mg/L nitrate contour. The transport characteristics of nitrate also support this conclusion.

Contaminants including nitrate, VOCs, metals, and radionuclides released from the SEPs entered the Unit 1 and Unit 2 ground water systems as a result of downward vertical gradients. The downward vertical potentials between Unit 1 and Unit 2 have facilitated the migration of contaminants from Unit 1 into Unit 2.

The downgradient extent of the Unit 1 ground water contaminant plumes were defined by the recent GSP field program for the southeast and northeast primary migration paths. The extent of these plumes are shown on Figure 22. The western (upgradient) extent of the Unit 1 contaminant plumes are poorly defined due in part to the presence of upgradient sources discussed above in Section 4.1.

The definition of the lateral and vertical extent of the ground water contaminant plumes in Unit 2 are more uncertain due to complexities associated with hydraulic interactions between Units 1 and 2, the effects of subsurface features (i.e., the ITS, pipelines, sumps, trenching, etc.), and other flow pathways discussed in Section 4.2.1.

4.3.1

Nitrate

In general, the overall distribution of nitrate in Units 1 and 2 are similar based on the historical and current data sets (Figures 10, 11, 22 and 23). Nitrate concentrations in Unit 2 (Figures 11 and 23) were higher than those in Unit 1 (Figures 10 and 22) within areas where the plumes overlapped. This configuration is consistent with the fact that the primary source of nitrate in the SEPs has been removed for several years. The lower concentrations in Unit 1 reflect flushing of the nitrate plume from Unit 1 by infiltration, and movement of the center of mass of the plume to Unit 2 as a result of downward vertical gradients.

The figures also indicate that the extent of nitrate contamination to the west is not well defined. As discussed in Section 4.1, other possible sources of nitrate may be located upgradient from OU4.

Based on the limited vertical hydraulic potential data between Units 2 and 3 from OU4, it appears that downward vertical potentials do exist between these units. However, the dramatic contrast between the permeabilities of Unit 2 and 3 limits the ability of nitrate-impacted ground water to migrate from Unit 2 into Unit 3. Conversely, the north-south oriented fault structure believed to exist north of the 207B Pond may be a potential pathway for nitrate ground water contamination from Unit 2 to Unit 3.

4.3.2 *Volatile Organic Compounds*

Based on the evaluation of historical data showing the distribution of VOCs in ground water in Units 1 and 2 (Figures 12 and 13) and our current understanding of ground water flow (Figures 7, 8, 20, and 21), it appears likely that the majority of the VOCs present in ground water beneath OU4 may have originated from a source(s) located upgradient (west or southwest) from the SEPs. Further evidence of upgradient VOC sources include the results of borehole data from the Industrial Area (Operable Unit 9), where carbon tetrachloride free product was observed.

Concentrations of VOCs above their respective MCLs are present in the northwest and southeast portions of the study area (Figure 13). The VOCs found in the southeast portion of the study area are related to sources outside OU4 (possibly the 903 pad), and are hydraulically captured by the South Walnut Creek drainage. Therefore they are unlikely to impact ground water quality at OU4 either now or in the future. The VOCs detected in the west and northwest portions of the study area are also associated with a source or sources outside OU4, in the Industrial Area (OU9). These VOCs, however, have migrated into the OU4 area and will impact any corrective measures taken for OU4 ground water.

The lack of qualitative or quantitative data for VOCs from the current GSP investigation limits the ability to be conclusive regarding the location of additional sources. Additional geophysical data were collected to the south and west of Pond C to define potential bedrock lows where DNAPLs could be located. However, the excessive number of interferences in this area (utilities, fences, roads) rendered the seismic data around Pond C (lines I and J) unusable for this purpose. Since these VOCs will play a role in the selection and design of a corrective action for OU4 ground water, and their source and extent were not completely defined in this field effort, they remain as a significant data gap for the OU4 Phase II CMS.

Based on the distribution of VOCs in Units 1 and 2 (Figures 12 and 13) and the evaluation of system hydraulics, the contaminants can potentially migrate either

northeast toward the ITS or southeast toward South Walnut Creek VOCs detected in ground water in the vicinity of the ponds have been detected in influent water to the ITS However, the VOC plumes do not appear to have migrated an appreciable distance beyond the SEPs

4.3.3

Radionuclides

The lateral and vertical extent of the radionuclide contamination (Figures 14 and 15) appears to be contained within the lateral and vertical extent of the nitrate plumes in Units 1 and 2 (Figures 22 and 23) As with nitrate, the extent of radionuclides in Unit 3 has not been defined Radionuclide data taken from RFEDS for several Unit 3 wells showed relatively low concentrations compared to Unit 2, however, data was scarce in the primary areas of concern and were also of questionable quality The difference in permeabilities between Units 2 and 3 should limit migration potential into Unit 3 As stated above in Section 4.3.1, the fault structure believed to exist north of the 207B Pond may be a potential pathway for ground water contamination

Of the ten radionuclides examined as part of the recent investigation, gross alpha, gross beta, and the uranium isotopes exhibited distinguishable trends with the SEPs identified as the source The remaining radionuclides exhibited highly variable data with no identifiable trends (see Figures 14 and 15)

The relative concentrations and distribution of nitrate and tritium suggest that the compounds originate from the same source (i.e., the SEPs) Although the uranium isotopes, gross alpha, and gross beta show more distinguishable trends, they do not relate as closely with nitrate in ground water This implies that the dispersion characteristics of tritium and nitrate may be similar

4.4

SUMMARY

This section summarizes the primary findings of this field investigation and data synthesis

- The ITS is not effective in capturing all contaminated ground water flow from the SEPs This is primarily due to two factors First, the ITS is not keyed into bedrock (Unit 2) along its length resulting in underflow of ground water in Unit 1 Second, and more importantly, ground water flows through Unit 2 down the hillside north of the SEPs Flow occurs throughout Unit 2, but is concentrated in paleochannels which are zones of more intensive fracturing and weathering in Unit 2 Nitrate concentrations downgradient of the ITS appear to be a combination of historical and current flow, and can not be attributed solely to ground water flow prior to installation of the ITS
- Nitrate is a good indicator of ground water contamination at OU4 within the context of filling data gaps for a CMS This is particularly true of a CMS

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focusing on additional passive capture of ground water downgradient from the SEPs. Nitrate data adequately describe the shape of the plume and the primary flow pathways, and also indicate the maximum downgradient extent of probable ground water remediation.

- The use of the geoprobeTM method for real-time analysis of ground water hydraulics and chemistry is an effective tool for investigation Unit 1 and 2 at OU4. When combined with field analytical tools, the GSP approach can be significantly faster and less expensive than traditional well installation. GSP sampling points are durable, and can be used for ongoing monitoring for at least two years. If additional GSP work is performed at OU4, some specific modifications to this field investigation are recommended:
 - ⇒ use of more effective drive points which are less susceptible to clay smearing
 - ⇒ addition of a field gas chromatograph (GC) for real-time analysis of VOCs, and
 - ⇒ collection of lithologic samples using the geoprobeTM rig to confirm stratigraphy
- The major flow pathways from the SEPs begin with paleochannels and linear features (fractures and one identified fault) which direct flow through and under the ITS to North Walnut Creek. A portion of flow from beneath the SEPs moves southeastward toward the South Walnut Creek drainage. South Walnut Creek appears to be a ground water divide for Units 1 and 2, and therefore captures all contaminated water moving southeast from the SEPs. It is not certain whether North Walnut Creek serves as a ground water divide for Unit 2. In addition, a fault trace running north from the SEPs may serve as a flow pathway across North Walnut Creek.
- In the time period since the source in the SEPs (i.e., the contaminated process water) has been removed, the center of mass of the nitrate plume has moved downward into Unit 2. Flushing from infiltration and upgradient flow has reduced the nitrate concentration in Unit 1. Vertical potentials around the SEPs are downward, but appear to be upward at North Walnut Creek and South Walnut Creek.
- An upgradient source of VOCs exists in or upgradient of the Industrial Area. VOCs from this source may include a DNAPL. The dissolved portion of the VOC plume has impacted the OU4 area on the western boundary, and has reached the ITS. Any future ground water remedial action at OU4 will need to plan for these VOCs in the influent stream.
- The outermost extent of nitrate contamination from OU4 has, for the most part, been adequately defined. This outer limit can serve as the extent boundary for other contaminants of concern at OU4 in designing additional ground water collection locations.

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RECOMMENDATIONS AND ADDITIONAL DATA REQUIREMENTS TO SUPPORT A CMS

Table 4 summarizes the objectives for the accelerated CMS strategy for ground water remediation. The table includes the data requirements, purpose, current status, and specific data gaps for each objective. Data requirements remaining following the incorporation of the results of the current investigation with historical data collected at OU4 are summarized below.

5.1

IDENTIFICATION OF DATA REQUIREMENTS

The primary areas of uncertainty surrounding the definition of the lateral and vertical extent of the ground water contamination involve the hydraulic interactions between Units 1 and 2, including the effects of subsurface features on preferential flow pathways. In addition, the hydraulic conductivity and transmissivity within Units 1 and 2 are not well defined in areas where potential additional ground water collection would take place. Emphasis should be placed on information required to quantify ground water flow in locations of potential ground water collection systems such as the ITS or along North Walnut Creek.

The contribution of upgradient sources adds an element of complexity to the evaluation of the lateral and vertical extent of contamination attributable to the SEPs. More information is required concerning the contributions of nitrate and VOCs from other sources (Section 4.1) to assess the fate and transport of contaminants within the areas surrounding the SEPs.

Lithologic samples are required to identify the Unit 1/2 interface in the majority of the Study Areas and to identify areas where subcropping sandstone lithofacies are suspected to occur in coincidence with DNAPL VOCs.

Although a solid base of information has been established for hydraulic conditions and ground water quality at OU4, additional hydraulic and chemical data required to support the CMS are discussed in the following sections. The data requirements listed below are summarized in Table 4 and are intended to collect the information necessary to meet the identified objectives (Table 4).

5.1.1

Hydraulic Data Requirements

Comprehensive ground water elevation monitoring survey data is required (preferably on a quarterly basis) using both the existing GSP and RCRA monitoring well and piezometer network, as well as additional wells or piezometers where required (see Section 5.2). This effort should be completed.

within each of the OU4 Study Areas to gain a more complete understanding of system hydraulics, determine potential contributions from other sources of nitrate and VOCs, evaluate the effectiveness of the ITS, and to evaluate effects of water level fluctuations on unsaturated areas

Hydraulic conductivity and transmissivity data is required in both Unit 1 and Unit 2 to determine the potential locations of a ground water collection system (i.e. the ITS, along North Walnut Creek, or proximal to the SEPs). Testing may include slug tests, short-term pumping tests and possibly long-term pumping tests. Existing wells and some of the proposed additional wells can be used for this effort.

5.1.2 Chemical Data Requirements

Nitrate analysis is required to confirm the northeast, southeast, and northwest extent of the ground water plume. Additional nitrate analysis is also required on the north side of North Walnut Creek to verify that the creek is acting as a hydraulic barrier to ground water flow from OU4.

VOC analyses are required north and west of 207 C-Pond to determine potential non-SEP source(s) and to evaluate the potential for DNAPLs. VOC analyses are also required to determine if the sandstone unit is acting as a preferential flow path for VOCs.

Analyses for gross alpha, gross beta and the uranium isotopes are required from existing wells to improve delineation of the radionuclide plumes. Additional radionuclide data may be required in areas north of North Walnut Creek depending on the results of the nitrate analyses.

5.2 RECOMMENDATIONS

It is recommended that ground water elevations be monitored in GSPs, RCRA wells, and piezometers within all OU4 Study Areas on a quarterly basis for at least a full year to evaluate seasonal variations and to gain a better understanding of system hydraulics. Many of the GSPs did not have sufficient time to reach static levels during the field investigation, therefore, the hydraulic head data may not have been suitable for a site-wide evaluation of lateral and vertical potentials. Additional wells should be installed adjacent to existing wells in key areas (along primary flow paths) and screened in different units (i.e., creating co-located vertical well "clusters") to assist in the understanding of lateral and vertical hydraulics and to obtain additional lithologic data to evaluate completion intervals of existing GSPs, RCRA wells, and piezometers. New monitoring wells,

piezometers or temporary wells are recommended for the following areas

- the north side of North Walnut Creek in Unit 1 and Unit 2 to confirm ground water flow direction in those units relative to the creek
- immediately downgradient of the ITS in Unit 1 and Unit 2 to determine the hydraulic effectiveness of the ITS and to potentially locate preferential pathways
- west of 207C Pond in Units 1 and Unit 2 to aid in determining the source(s) of VOCs in that area
- south of 207 B-South Pond in Unit 2 to assist in understanding system hydraulics
- in Unit 3 adjacent to selected wells completed in Unit 1 and /or Unit 2 for collection of hydraulic and water quality data

Aquifer testing is also recommended in both Unit 1 and Unit 2 to determine hydraulic conductivity and transmissivity in vicinity of potential collection features (i.e. along North Walnut Creek or proximal to the SEPs). Although much data already exists for Unit 1 resulting from the operation of the ITS, it is recommended that slug tests and short-term pumping tests be conducted for general characterization of Unit 1 and Unit 2 at potential collection sites. Long-term pumping tests should be conducted after the screening of alternatives is completed and potential collection sites have been selected for detailed evaluation.

The project team recommended that the field effort include the collection of lithologic samples; however, lithologic samples were not collected as part of the recent field program. Although originally intended, the recent field program did not evaluate the potential presence of DNAPLs at OU4. Other potential sources require further analysis for VOCs and DNAPLs. Also, due to circumstances beyond the control of the project team, the VOCs of concern were not evaluated as part of the recent GSP investigation at OU4. At least one complete sampling round should be conducted for the key VOCs within the appropriate Study Areas to quantify the VOCs originating from the SEPs.

Additional information is also required concerning the potential north-south trending fault which may coincide with one of the primary flow pathways. This fault may act as a sink for potential contaminants, or may create new flow pathways to locations outside the OU4 study area (i.e., north of North Walnut Creek).

The current ground water data collection program at OU4 should be re-evaluated to focus on efforts that support the technical understanding of ground water quality and hydraulics in this area. The current program is costly, and contains

many elements which are not required for ground water characterization. In addition, the current program does not provide the data needed to complete a CMS at OU4. Recommended changes in the current program include:

- inclusion of water level measurements at all wells, GSP locations, and piezometers in and around OU4,
- elimination of sample analyses at existing RCRA wells which, based on the new understanding of ground water at OU4, do not contribute to the data requirements of the CMS,
- reduction in frequency of sample analysis at wells which have not historically shown significant variation in results, and
- elimination in all samples of analytes which are not relevant to the OU4 ground water issue (i.e., limit the analyses to nitrate, supplemented periodically with VOCs and radionuclides)

Finally, it is recommended that an analysis of the treatment goals or action levels be conducted with respect to radionuclides to focus future characterization efforts on the appropriate constituents in the appropriate locations.

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EG&G Rocky Flats, Inc 1991 General Radiochemistry and Routine Analytical Services Protocol (GRRASP) Prepared for U S Department of Energy, Rocky Flats Environmental Technology Site, Golden, Colorado

Table 1
Ground Water Standards for Radiological and Key VOC Constituents

	MCL or State Standard ⁽¹⁾	RCRA Well ID	1st Quarter 1995 Maximum Hit
Volatile Organic Compounds	(ug/L)		(ug/L)
1,1-Dichloroethylene	7	P215789	81
CarbonTetrachloride	5	P210189	4700
Chloroform	100	P210189	162
Tetrachloroethylene	5	2291	1981
Trichloroethylene	5	P210189	2200
Radiological Constituents	(pCi/L)		(pCi/L)
Uranium-238	10/100 ⁽²⁾	B208689	42
Uranium-235	10/90 ⁽²⁾	B210489	6
Uranium-233/234	10/90 ⁽²⁾	B208689	69
Tritium	500	P209589	11349
Cesium-134	80	P209889	3
Strontium-89/90	8	P208989	4
Radium-226/228	5	P207989	7
Plutonium-239/240	0 05	P209189	0 16
Gross Beta	19	P210089	79
Gross Alpha	11	P208989	110

FOOTNOTES

(1) Values listed for VOCs are MCLs Values for radiological constituents are Colorado State standards

(2) The Colorado state standard for total Uranium is 10 pCi/liter The second value is an isotope-specific screening value assumed to produce a total body or organ dose of 4 mrem/yr, assuming ingestion of 2 liters of water per day This value was developed using established EPA methodology presented in 40 CFR 141.16

Summary of Geoprobe™ Activity in OU4 Study Areas

Geoprobe Identification	Study Area	Date Installed	Total Depth (feet)	Completion Zone	Screened Interval (ft BGS) (2)	May/June 1995 Depth to Water (Top of Casing) (Feet)	April/May/June 1995 Nitrate Level (mg/L)	COMMENTS
20195	2	3/22/95	9	Unit 1	4 - 9	2.91	85.7	Wellpoint installed without hydrating bentonite
20295	2	3/22/95	8	Unit 1	3 - 8	1.32	0.16	Wellpoint reinstalled without hydrating bentonite Twinned by deeper hole 21295
20395	8	3/22/95	18	Unit 2	13 - 18	18.12	NA (3)	Weathered bedrock at 0' bgs Twinned by shallower hole 21395
20495	8	3/22/95	20	Unit 2	15 - 20	Dry	7.7	Weathered bedrock at 0' bgs Twinned by shallower hole 21495
20595	1	3/22/95	20	Unit 2	15 - 20	Dry	NA (3)	Weathered bedrock at 10' bgs, Unit 1 is dry at this location
20695	1	3/22/95	9	Unit 1	4 - 9	7.16	2.05	Not deep enough for weathered bedrock
20795	1	3/22/95	8	Unit 1	3 - 8	5.00	NA (3)	Not deep enough for weathered bedrock Twinned by deeper hole 21595
20895	1	3/23/95	18	Unit 2	13 - 18	Dry	NA (3)	Weathered bedrock at 10' bgs Unweathered bedrock at 20' bgs
20995	1	3/23/95	10	Unit 1	5 - 10	3.47	0.31	
21095	1	3/23/95	16	Unit 1&2	11 - 16	15.43	NA (1)	
21195	2	3/23/95	16	Unit 1&2	11 - 16	Dry	NA (1)	Weathered bedrock at 14' bgs Note this well may be screened across Units 1& 2
21295	2	3/24/95	13	Unit 1&2	8 - 13	7.44	0.44	Weathered bedrock at 14' bgs Note this well may be screened across Units 1& 2
21395	8	3/24/95	13	Unit 2	8 - 13	Dry	NA (1)	Twin to 20295 but deeper
21495	8	3/24/95	15	Unit 2	10 - 15	Dry	NA (1)	Weathered bedrock at 0' bgs Twin to 20395 but shallower
21595	1	3/24/95	13	Unit 2	8 - 13	Dry	NA (1)	Weathered bedrock at 0' bgs Twin to 20495 but shallower
21695	3	3/27/95	10	Unit 1	5 - 10	5.75	208	Weathered bedrock at 11' bgs Twin to 20795 but deeper
21795	3	3/27/95	15	Unit 1	9 - 14	8.11	0.53	Weathered bedrock at 8' bgs Note this well may be screened across Units 1& 2
21895	3	3/27/95	30	Unit 2	24 - 30	Dry	NA (1)	Weathered bedrock at 14' bgs
21995	3	3/28/95	31	Unit 2	26 - 31	9.00	48.4	Weathered bedrock at 20' bgs
22095	3	3/28/95	11.8	Unit 1	6.8 - 11.8	7.60	8.15	Not deep enough for weathered bedrock
22195	3	3/28/95	10	Unit 1	5 - 10	6.27	6.24	Weathered bedrock at 8' to 9' bgs
22295	7	3/30/95	12	Unit 1	7 - 12	5.96	80.6	
22395	7	3/30/95	17	Unit 2	12 - 17	6.15	67.8	
22495	6	3/30/95	15	Unit 2	10 - 15	5.50	23.2	
22595	6	3/30/95	20	Unit 2	15 - 20	Dry	NA (3)	
22695	6	3/30/95	13	Unit 1	8 - 13	Dry	NA (3)	Not deep enough for weathered bedrock
22795	7	3/30/95	16	Unit 2	11 - 16	5.80	4.7	
22895	2	3/31/95	15	Unit 2	10 - 15	7.57	9.31	Weathered bedrock at 10' bgs
22995	2	3/31/95	10.5	Unit 1	5.5 - 10.5	7.50	1.4	
23095	1	3/31/95	13	Unit 2	8 - 13	14.38	13	Weathered bedrock at 8' bgs in sandstone unit
23195	1	3/31/95	8.2	Unit 1	3.2 - 8.2	3.75	2.8	
23295	3	3/31/95	10.5	Unit 2	5.5 - 10.5	1.47	13.8	Weathered bedrock at 1' bgs in sandstone unit
23395	3	3/31/95	16	Unit 1	11 - 16	0.01	11.7	Weathered bedrock estimated at 15' bgs
23495	3	3/31/95	10	Unit 2	5 - 10	2.20	0.2	
23595	7	4/3/95	20	Unit 2	15 - 20	5.60	0.71	Weathered bedrock at 15' bgs
23695	7	4/3/95	15	Unit 1	10 - 15	5.60	3.63	
23795	6	4/3/95	28	Unit 2	23 - 28	24.27	104	
23895	8	4/3/95	13	Unit 1	8 - 13	4.25	0.77	
23995	3	4/4/95	16	Unit 2	11 - 16	12.68	0.25	Weathered bedrock at 11' bgs
24095	3	4/4/95	11	Unit 1	6 - 11	7.67	0.12	
24195	3	4/4/95	15	Unit 1	10 - 15	1.00	0.6	Weathered bedrock at 10' bgs
24295	3	5/8/95	7	Unit 1	4 - 7	0.01	0.109	

Summary of Geoprobe™ Activity in OU4 Study Areas

Geoprobe Identification	Study Area	Date Installed	Total Depth (feet)	Completion Zone	Screened Interval (ft BGS) (1)	May/June 1995 Depth to Water (Top of Casing) (Feet)	April/May/June 1995 Nitrate Level (mg/L)	COMMENTS
24395	6	4/4/95	14	Unit 2	9 - 14	6.43	44.4	110% cased from 14' to 3'
24495	2	4/5/95	12	Unit 2	7 - 12	8.00	0.33	Weathered bedrock at 7' bgs
24595	2	4/5/95	7	Unit 1	3.5 - 7	4.98	0	
24695	1	4/5/95	15	Unit 2	10 - 15	3.57	5.16	Twin to 23395
24795	3	4/5/95	22	Unit 2	17 - 22	0.50	11.9	Weathered bedrock at 7' bgs
24895	6	4/6/95	12	Unit 2	7 - 12	5.43	54.7	Weathered bedrock at 6' bgs
24995	6	4/6/95	11	Unit 2	6 - 11	0.01	1260	Weathered bedrock at 2' bgs
25095	6	4/6/95	10	Unit 2	5 - 10	3.00	114	Weathered bedrock at 2' bgs
25195	6	4/6/95	10	Unit 2	5 - 10	0.50	434	Weathered bedrock at 2' bgs
25295	6	4/6/95	10	Unit 1	5 - 10	6.03	2	Weathered bedrock at 11' bgs in adjacent well 219189
25395	1	4/7/95	16	Unit 2	11 - 16	3.83	0.88	
25495	4	4/7/95	6	Unit 1	3 - 6	Dry	NA (1)	Weathered bedrock at 5' bgs
25595	4	4/7/95	13	Unit 1	8 - 13	Dry	NA (1)	Weathered bedrock at 12' bgs
25695	4	4/7/95	11	Unit 1	6 - 11	9.90	NA (1)	Weathered bedrock at 10.5' bgs
25795	4	4/12/95	12	Unit 1	7 - 12	Dry	NA (1)	
25895	4	4/12/95	10	Unit 1	5 - 10	Dry	NA (1)	
25995	4	5/1/95	8	Unit 1	3 - 8	2.35	182.4	
26095	3	5/2/95	8	Unit 1	3 - 8	6.32	15.6	Weathered bedrock at 8' bgs
26195	3	5/2/95	10	Unit 1	5 - 10	5.00	1.67	
26295	3	5/2/95	11	Unit 1	6 - 11	4.50	9.61	
26395	3	5/2/95	15	Unit 1	10 - 15	8.30	0.19	
26495	6	5/2/95	10	Unit 2	5 - 10	3.50	\$ 8	
26595	6	5/3/95	6	Unit 1	3 - 6	Dry	NA (1)	
26695	6	5/3/95	10	Unit 2	7 - 10	3.64	3.99	
26795	6	5/3/95	10	Unit 2	7 - 10	9.61	NA (1)	
26895	3	5/3/95	24	Unit 2	23 - 24	6.49	0.68	
26995	ITS (1)	5/5/95	22	Unit 2	17 - 22	9.10	47.1	Weathered bedrock at 9' bgs
27095	ITS (1)	5/5/95	9	Unit 1	4 - 9	1.83	2.6	
27195	8	5/5/95	20	Unit 2	15 - 20	Dry	NA (1)	
27295	4	5/5/95	14	Unit 2	9 - 14	7.67	\$40	
27395	3	5/8/95	20	Unit 2	13 - 20	8.12	19.3	
27495	2	5/8/95	14	Unit 2	4 - 14	Dry	NA (1)	
27595	8	5/8/95	9	Unit 1	4 - 9	Dry	NA (1)	
27695	2	5/8/95	12	Unit 2	7 - 12	5.30	4.47	
27795	ITS (1)	5/8/95	22	Unit 2	17 - 22	16.10	\$ 7	
27895	4	5/9/95	17	Unit 2	12 - 17	Dry	NA (1)	
27995	ITS (1)	5/10/95	8	Unit 1	5 - 8	2.91	1.75	
28095	ITS (1)	5/10/95	17	Unit 2	12 - 17	Dry	NA (1)	
28195	ITS (1)	5/10/95	8	Unit 1	5 - 8	Dry	NA (1)	
28295	2	5/10/95	15	Unit 2	6 - 15	4.34	1.09	
28395	8	5/10/95	14	Unit 2	4 - 14	4.28	10.75	
28495	8	5/10/95	10	Unit 2	7 - 10	Dry	NA (1)	

Summary of Geoprobe™ Activity in OU4 Study Areas

Geoprobe Identification	Study Area	Date Installed	Total Depth (feet)	Completion Zone	Screened Interval (ft BGS) (2)	May/June 1995 Depth to Water (Top of Casing) (Feet)	April/May/June 1995 Nitrate Level (mg/L)	COMMENTS
28595	4	5/10/95	13	Unit 2	8 - 13	5.67	0.2	
28695	3	5/11/95	10	Unit 1	5 - 10	2.90	19.7	
28795	3	5/11/95	15	Unit 1	10 - 15	Dry	NA (3)	
28895	3	5/11/95	11	Unit 2	6 - 11	4.49	0.36	
28995	3	5/11/95	22	Unit 2	18 - 22	10.10	0.725	
29095	6	5/11/95	18	Unit 2	13 - 18	3.50	4.47	
29195	6	5/11/95	8	Unit 1	5 - 8	6.71	NA (1)	
29295	6	5/11/95	11	Unit 2	6 - 11	7.00	185	
29395	6	5/11/95	12	Unit 2	7 - 12	2.50	136	
29495	1	5/12/95	21	Unit 2	16 - 21	Dry	NA (3)	
29595	ITS (1)	5/12/95	14	Unit 2	9 - 14	9.70	5.62	
29695	8	5/12/95	15	Unit 2	7 - 15	0.58	0.99	
29795	1	5/12/95	7	Unit 1	3 - 7	2.36	0.96	
29895	8	5/12/95	14	Unit 2	9 - 11	Dry	NA (1)	
29995	2	5/12/95	10	Unit 2	5 - 10	Dry	NA (1)	
30095	5	5/12/95	18.5	Unit 2	13.5 - 18.5	12.23	34.8	
30195	4	5/12/95	20	Unit 2	15 - 20	Dry	NA (3)	
30295	5	5/12/95	18	Unit 2	13 - 18	17.57	0.53	
30395	4	5/12/95	20	Unit 2	16 - 20	Dry	NA (1)	
30495	5	5/15/95	20	Unit 2	12 - 20	Dry	NA (3)	
30595	5	5/15/95	22	Unit 2	15 - 22	8.24	203	
30695	5	5/15/95	15	Unit 2	7 - 15	8.82	16.9	
30795	ITS (1)	5/15/95	20	Unit 2	15 - 20	Dry	NA (3)	
30895	ITS (1)	5/15/95	21	Unit 2	11 - 21	Dry	NA (1)	

FOOTNOTES

- (1) ITS refers to Interceptor Trunch System
 (2) BGS= Below Ground Surface
 (3) Data not available

Table 3
Comparison of Nitrate Results from Geoprobe™ Investigation and RCRA Wells

Geoprobe Identification	Geoprobe Northing Survey Coordinate ⁽¹⁾	Geoprobe Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	Geoprobe May/June 1995 Nitrate Level (mg/L)	Adjacent RCRA Well Nitrate Level (mg/L)	RCRA Well ID
GP20195	751854 7	2085824	5847 6	Unit 1	85 70	66 967	1586
GP20295	751837 8	2085936	5844 2	Unit 1	0 16		
GP20395	751728 8	2086285	5851 8	Unit 2	NA ⁽²⁾		
GP20495	751670 4	2086366	5857 4	Unit 2	7 70		
GP20595	752064 3	2085330	5911 8	Unit 2	NA		
GP20695	752031 9	2085588	5879 1	Unit 1	2 05		
GP20795	751935 2	2085601	5857 9	Unit 1	NA ⁽²⁾		
GP20895	752109 7	2085788	5886 8	Unit 2	NA ⁽²⁾		
GP20995	751870 8	2085326	5864 8	Unit 1	0 31		
GP21095	751945 1	2085450	5868 4	Unit 1&2	NA ⁽²⁾		
GP21195	751922 8	2086613	5837 7	Unit 1&2	NA ⁽²⁾		
GP21295	751836 3	2085938	5844 3	Unit 1&2	0 44		
GP21395	751729	2086287	5851 5	Unit 2	NA ⁽²⁾		
GP21495	751669 7	2086366	5857 5	Unit 2	NA ⁽²⁾		
GP21595	751934 6	2085601	5857 8	Unit 2	NA ⁽²⁾		
GP21695	750328 3	2085220	5969 8	Unit 1	208 00		
GP21795	750190 9	2085299	5967 7	Unit 1	0 53		
GP21895	750063 5	2085359	5967 0	Unit 2	NA ⁽²⁾		
GP21995	750263 6	2085544	5963 7	Unit 2	48 40		
GP22095	750400 1	2085327	5966 1	Unit 1	8 15	7 55	P207689
GP22195	750412 6	2085489	5962 0	Unit 1	6 24		
GP22295	750744 3	2084406	5979 8	Unit 1	80 60	5 935	2286
GP22395	750743 1	2084402	5979 8	Unit 2	67 80	12 437	P210189
GP22495	751010 2	2084186	5966 1	Unit 2	23 20	4 141	P209389
GP22595	750959 5	2084045	5980 2	Unit 2	NA ⁽²⁾		
GP22695	750959 6	2084046	5980 1	Unit 1	NA ⁽²⁾		
GP22795	750390 8	2084174	5985 9	Unit 2	4 70		
GP22895	751889 2	2086650	5840 5	Unit 2	9 31		
GP22995	751890 8	2086650	5840 3	Unit 1	1 40		
GP23095	752142 1	2086585	5832 1	Unit 2	13 00		
GP23195	752143 4	2086584	5832 4	Unit 1	2 80		
GP23295	750398 7	2086046	5935 8	Unit 2	13 80		
GP23395	750236 5	2086104	5916 8	Unit 1	11 70		
GP23495	750462 6	2086314	5930 0	Unit 2	0 20		
GP23595	750726	2083854	5987 3	Unit 2	0 71		
GP23695	750727 2	2083854	5987 4	Unit 1	3 63		
GP23795	750996 8	2084632	5977 4	Unit 2	104 00	152 711	P209489
GP23895	750716 1	2084187	5982 5	Unit 1	0 77		
GP23995	750047 3	2085538	5949 5	Unit 2	0 25		
GP24095	750047 4	2085537	5949 6	Unit 1	0 12		
GP24195	750113 9	2085658	5943 9	Unit 2	0 60		
GP24295	750114 8	2085659	5944 0	Unit 1	0 11		
GP24395	751175 2	2084303	5944 1	Unit 2	44 40		
GP24495	751904 2	2086441	5838 4	Unit 2	0 33		
GP24595	751905 4	2086441	5838 1	Unit 1	0 00		
GP24695	751872	2085327	5864 9	Unit 2	5 16		
GP24795	750235 7	2086106	5916 5	Unit 2	11 90		
GP24895	750986 2	2085468	5956 0	Unit 2	54 70		
GP24995	751058 7	2085303	5949 2	Unit 2	1260 00	4921 944	P209589

Table 3
Comparison of Nitrate Results from Geoprobe™ Investigation and RCRA Wells

Geoprobe Identification	Geoprobe Northing Survey Coordinate ⁽¹⁾	Geoprobe Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	Geoprobe May/June 1995 Nitrate Level (mg/L)	Adjacent RCRA Well Nitrate Level (mg/L)	RCRA Well ID
GP25095	751214 7	2084694	5936 5	Unit 2	114 00	481 287	1786
GP25195	751220 2	2084432	5937 7	Unit 2	434 00		
GP25295	751228	2084008	5941 0	Unit 1	2 00		
GP25395	751887 9	2085474	5857 9	Unit 2	0 88		
GP25495	751650 9	2085290	5875 7	Unit 1	NA ⁽²⁾		
GP25595	751616 5	2084846	5901 5	Unit 1	NA ⁽²⁾		
GP25695	751596 7	2084746	5900 1	Unit 1	NA ⁽²⁾		
GP25795	751662 7	2084826	5897 6	Unit 1	NA ⁽²⁾		
GP25895	751707 3	2084831	5891 9	Unit 1	NA ⁽²⁾		
GP25995	751736 9	2085272	5867 2	Unit 1	182 40		
GP26095	750397 5	2085156	5972 6	Unit 1	15 60		
GP26195	750136 2	2085200	5968 9	Unit 1	1 67		
GP26295	750275 6	2085359	5967 3	Unit 1	9 61		
GP26395	750148 7	2085469	5965 3	Unit 1	0 19		
GP26495	751023 5	2085476	5952 0	Unit 2	5 80		
GP26595	751109	2085296	5944 3	Unit 2	NA ⁽²⁾		
GP26695	751284 2	2084671	5929 1	Unit 2	3 99		
GP26795	751285 8	2084467	5930 1	Unit 2	NA ⁽²⁾		
GP26895	750399 8	2085588	5960 7	Unit 2	0 68		
GP26995	751226 7	2085432	5936 2	Unit 2	47 10		
GP27095	751226 2	2085432	5936 2	Unit 2	2 60		
GP27195	751369 8	2086388	5900 2	Unit 2	NA		
GP27295	751650 5	2085291	5876 0	Unit 2	540 00		B208689
GP27395	750038 3	2085704	5935 4	Unit 2	19 30		
GP27495	751784 1	2086311	5850 5	Unit 2	NA ⁽²⁾		
GP27595	751668 8	2086238	5861 2	Unit 2	NA ⁽²⁾		
GP27695	751749 1	2085740	5867 3	Unit 2	4 47		
GP27795	751478 8	2085015	5906 3	Unit 2	3 70		
GP27895	751503 7	2085548	5908 0	Unit 2	NA ⁽³⁾		
GP27995	751473 8	2085011	5907 5	Unit 1	1 75		
GP28095	751418 2	2085065	5918 4	Unit 2	NA ⁽²⁾		
GP28195	751419 5	2085063	5918 4	Unit 1	NA ⁽²⁾		
GP28295	751762 6	2086358	5852 1	Unit 2	1 09		
GP28395	751678	2086272	5836 0	Unit 2	10 75		
GP28495	751260 7	2086009	5900 6	Unit 2	NA ⁽²⁾		
GP28595	751164 5	2085930	5923 5	Unit 2	0 20	2 59	B208189
GP28695	750160 9	2085750	5940 3	Unit 2	19 70		
GP28795	750269 6	2085794	5945 3	Unit 2	NA ⁽²⁾		
GP28895	750412 1	2085802	5951 4	Unit 2	0 36		
GP28995	750148 8	2085468	5965 4	Unit 2	0 73		
GP29095	750853 8	2085788	5953 1	Unit 2	4 47		
GP29195	751066 2	2085386	5948 5	Unit 2	NA ⁽²⁾		
GP29295	751196 4	2085114	5936 9	Unit 2	185 00		
GP29395	751249 7	2084237	5934 6	Unit 2	136 00		
GP29495	751913 6	2085273	5878 8	Unit 2	NA ⁽²⁾		
GP29595	751087 1	2085755	5943 6	Unit 2	5 62		
GP29695	751283 8	2086297	5905 1	Unit 2	0 99		
GP29795	751944 9	2085738	5847 3	Unit 1	0 96		

Table 3
Comparison of Nitrate Results from Geoprobe™ Investigation and RCRA Wells

Geoprobe Identification	Geoprobe Northing Survey Coordinate ⁽¹⁾	Geoprobe Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	Geoprobe May/June 1995 Nitrate Level (mg/L)	Adjacent RCRA Well Nitrate Level (mg/L)	RCRA Well ID
GP29895	751455 7	2086192	5873 0	Unit 2	NA ⁽²⁾	160 719	P210089
GP29995	751665 9	2085551	5878 1	Unit 2	NA ⁽²⁾		
GP30095	751595 3	2084745	5899 8	Unit 2	34 80		
GP30195	751662	2084826	5897 7	Unit 2	NA ⁽²⁾		
GP30295	751705 5	2084831	5892 1	Unit 2	0 53		
GP30395	751617 3	2084846	5901 4	Unit 2	NA ⁽²⁾		
GP30495	751485 2	2084808	5912 8	Unit 2	NA ⁽²⁾		
GP30595	751497 2	2084617	5910 4	Unit 2	203 00		
GP30695	751450 7	2084487	5920 8	Unit 2	NA ⁽²⁾		
GP30795	751473 2	2085135	5912 0	Unit 2	NA ⁽²⁾		
GP30895	751442 7	2085222	5915 1	Unit 2	NA ⁽²⁾		

FOOTNOTES

(1) State Plane Coordinate System

(2) Data not available

Table 4
Summary of Phase II RFI/CMS Objectives and Data Requirements

Phase II RFI/RI Objectives	Data Requirements	Purpose of Data	Current Status	Data Gaps
I. Characterize upper and lower hydrologic systems and associated hydraulic and chemical interactions	Determine key ground water parameters including hydraulic properties, flow direction, chemical analysis, thickness, aerial extent, temporal variation, etc	Define hydraulic conditions and interactions between systems	Several reports have been developed which include much of this information A detailed data quality review was conducted to define specific data gaps	Ground water and surface water hydraulics and hydrologic relationships Identify artificial stresses on ground water system
II. Characterize nature of contamination in ground water	<ol style="list-style-type: none"> 1 Chemical analyses (nitrate, VOCs, radionuclides) 2 Determine presence of DNAPL 	<ol style="list-style-type: none"> 1 Site characterization 2 Evaluation of treatment alternatives 3 Determine source influence 	<p>A detailed data quality review was conducted to define specific data gaps The nature and extent of nitrate, VOC, and radiological contamination in groundwater was evaluated</p>	<p>The spatial extent of VOC contamination requires further evaluation Identify characteristics of contaminants relative to potential treatment technologies</p>

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Table 4
Summary of Phase II RFI/CMS Objectives and Data Requirements

Phase II RFI/RI Objectives	Data Requirements	Purpose of Data	Current Status	Data Gaps
III. Delineate extent of groundwater contamination	<ol style="list-style-type: none"> 1 Perform chemical analyses 2 Determine interaction of hydraulic systems (e g , ground water, surface water, seeps) and lithostratigraphic units (e g , Units 1, 2, and 3) 	<ol style="list-style-type: none"> 1 Determine lateral and vertical extent of contamination 2 Site characterization 3 Evaluation of treatment alternatives 	<p>Much of the background data has been collected to support this objective</p> <p>Geophysical data was collected to support the selection of locations for well points to determine the extent of contamination</p>	Extent of ground water contaminant plume
IV Determine contribution of upgradient sources	<ol style="list-style-type: none"> 1 Perform chemical analyses 2 Determine hydraulic properties and flow direction 3 Investigate operations and potential releases associated with adjacent OUs 	Determine influence of other sources	<p>More information is required to accurately determine flow direction to evaluate contribution from other sources</p> <p>Geophysical data was collected to support the selection of locations for well points for further analyses</p>	Types and quantities of contaminants derived from upgradient sources

Table 4
Summary of Phase II RFI/CMS Objectives and Data Requirements

Phase II RFI/RI Objectives	Data Requirements	Purpose of Data	Current Status	Data Gaps
V. Evaluate fate and transport characteristics in groundwater	<ol style="list-style-type: none"> 1 Determine flow direction and hydraulic properties 2 In situ chemical/physical properties and selected chemical analyses 3 Identify preferential groundwater flow pathways and barriers 4 Identify interactions between hydrostratigraphic units (e g , Units 1, 2, and 3) 	Determine dynamics of contaminant plume and ground water flow in relation to the three hydrostratigraphic units (e g , Units 1, 2, and 3)	Several reports have been developed which include much of this information A detailed data quality review was conducted to define specific data gaps	Identify preferential ground water flow paths and barriers to flow Identify attenuative properties of aquifer systems Determine chemical transport properties of hydrostratigraphic units
VI. Evaluate effectiveness of Interceptor Trench System (ITS)	<ol style="list-style-type: none"> 1 Determine lithologic characteristics 2 Determine hydraulic properties and flow direction 3 Determine other hydrologic influences 4 Perform chemical analyses 	Evaluate the performance of the ITS and evaluate in relation to other groundwater treatment alternatives	The effectiveness of the system has been estimated at approximately 80% based on the length of the trench assumed to be keyed into bedrock	Confirm hydraulic properties of ITS and hydrologic influences on the groundwater flow system Determine the mechanical integrity of the ITS
VII Evaluate compliance with ARARs and other regulatory requirements	<ol style="list-style-type: none"> 1 Selected chemical analyses 2 Analysis of regulatory requirements for ground water 	Evaluate federal and state regulatory requirements	Regulatory requirements have been established for ground water at OU4	Confirm ARARs and other applicable regulatory criteria for groundwater

APPENDIX A
RFEDS Ground Water Elevation Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Depth to Water (Top of Casing) (Feet)	September 1994 Ground Water Elevation (Feet)	2nd Quarter 1995 Depth to Water (Top of Casing) (Feet)	2nd Quarter 1995 Ground Water Elevation (Feet)
308-P-1	751968	2084165 03	Unit 2	NA ⁽²⁾	NA ⁽²⁾	25 41	5418 7
308-P-2	752052	2084580 23	Unit 2	NA ⁽²⁾	NA ⁽²⁾	30 29	5913 73
5074	751066	2084732	Unit 2	Dry	NA ⁽²⁾	0	5958 68
5174	751070	2084934	Unit 2	9 34	5941 57	2 5	5948 41
5274	751099	2085104	Unit 1 2	Dry	NA ⁽²⁾	2 76	5962 8
5374	750581	2086325	Unit 2	Dry	NA ⁽²⁾	6 92	5949 07
5474	751074	2086320	Unit 2	13 10	5923 71	5 61	5931 2
5574	749656	2084885	Unit 2	NA ⁽²⁾	NA ⁽²⁾	0	5954 07
5674	750989	2086417	Unit 2	NA ⁽²⁾	NA ⁽²⁾	14 45	5941 86
5774	750822	2086075	Unit 2	16 10	5943 04	15 13	5944 01
5874	751567	2085830	Unit 2	16 90	5867 16	15 1	5868 96
5974	751815	2085580	Unit 1	13 39	5845 43	15 19	5843 63
6074	752106	2085775	Unit 2	Dry	NA ⁽²⁾	0	5888 84
6174	752079	2085308	Unit 2	Dry	NA ⁽²⁾	0	5916 92
6274	751738	2085154	Unit 2	10 10	5864 23	8 67	5865 66
6374	751806	2084589	Unit 2	15 75	5893 8	10 55	5899
1386	751857	2086051	Unit 1	9 48	5833 11	4 19	5838 4
1486	751856	2085838	Unit 3	11 80	5834 91	NA ⁽²⁾	NA ⁽²⁾
1586	751852	2085812	Unit 1	7 77	5842 86	NA ⁽²⁾	NA ⁽²⁾
1686	751747	2085260	Unit 3	7 40	5862 15	NA ⁽²⁾	NA ⁽²⁾
1786	751740	2085242	Unit 1	7 88	5861 69	NA ⁽²⁾	NA ⁽²⁾
1886	751522	2085831	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
1986	750894	2083296	Unit 1	NA ⁽²⁾	NA ⁽²⁾	1 84	5942 02
2286	750718	2084411	Unit 1	10 49	5969 06	NA ⁽²⁾	NA ⁽²⁾
2386	750338	2084259	Unit 3	88 99	5893 47	NA ⁽²⁾	NA ⁽²⁾
2486	750338	2084277	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
2586	750412	2084831	Unit 3	33 14	5944	NA ⁽²⁾	NA ⁽²⁾
2686	750411	2084841	Unit 1	12 44	5964 73	NA ⁽²⁾	NA ⁽²⁾
2786	750781	2085238	Unit 3	83 13	5880 75	NA ⁽²⁾	NA ⁽²⁾
2986	750599	2085687	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
3086	751078	2084921	Unit 2	8 11	5950 28	NA ⁽²⁾	NA ⁽²⁾
3186	751051	2084764	Unit 2	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
3286	751050	2084743	Unit 3	55 55	5912 37	NA ⁽²⁾	NA ⁽²⁾
3386	749950	2085003	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
3486	750162	2086193	Unit 3	22 00	5891 95	NA ⁽²⁾	NA ⁽²⁾
3586	750167	2086219	Unit 1	9 00	5903 76	NA ⁽²⁾	NA ⁽²⁾
3686	750387	2086820	Unit 1	Dry	NA ⁽²⁾	4 84	5880 38
4286	749559	2087114	Unit 1	NA ⁽²⁾	NA ⁽²⁾	5 41	5952 46
4386	749404	2085869	Unit 1	NA ⁽²⁾	NA ⁽²⁾	8 5	5965 96
1887	749404	2086339	Unit 3	NA ⁽²⁾	NA ⁽²⁾	125 53	5843 96
2187	749969	2085799	Unit 1	9 05	5920 64	NA ⁽²⁾	NA ⁽²⁾
2287	749924	2085822	Unit 3	80 65	5852 15	NA ⁽²⁾	NA ⁽²⁾
2487	749751	2086746	Unit 1	NA ⁽²⁾	NA ⁽²⁾	5 44	5954 25
2587	749719	2086748	Unit 2	NA ⁽²⁾	NA ⁽²⁾	7 46	5953 52
3887	750396	2085094	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
5687	750638	2084423	Unit 1	9 13	5970 64	5 53	5974 24
B208089	751143	2085876	Unit 1	13 60	5923 47	NA ⁽²⁾	NA ⁽²⁾
B208189	751138	2085885	Unit 2	25 16	5912 3	NA ⁽²⁾	NA ⁽²⁾

APPENDIX A
RFEDS Ground Water Elevation Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Depth to Water (Top of Casing) (Feet)	September 1994 Ground Water Elevation (Feet)	2nd Quarter 1995 Depth to Water (Top of Casing) (Feet)	2nd Quarter 1995 Ground Water Elevation (Feet)
B208289 ⁽³⁾	751739	2086289	Unit 2	17 66	5835 29	NA ⁽²⁾	NA ⁽²⁾
B208389 ⁽³⁾	751687	2085584	Unit 2	10 43	5868 23	NA ⁽²⁾	NA ⁽²⁾
B208489	751683	2085636	Unit 2	Drv	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
B208589 ⁽³⁾	751804	2085477	Unit 1	5 94	5852 41	NA ⁽²⁾	NA ⁽²⁾
B208689	751728	2085250	Unit 2	16 94	5852 66	NA ⁽²⁾	NA ⁽²⁾
B208789	751755	2084450	Unit 1	7 98	5901 05	2 96	5906 07
B210389	751696	2085116	Unit 2	15 26	5860 06	NA ⁽²⁾	NA ⁽²⁾
B210489	751802	2085513	Unit 1	6 60	5852 11	3 12	5855 59
B213789	750538	2086677	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
P207389	750195	2084468	Unit 2	8 53	5974 24	NA ⁽²⁾	NA ⁽²⁾
P207589	750395	2084843	Unit 2	26 00	5949 96	NA ⁽²⁾	NA ⁽²⁾
P207689	750398	2085318	Unit 1	9 15	5958 73	NA ⁽²⁾	NA ⁽²⁾
P207789	750392	2085343	Unit 2	29 61	5938 14	NA ⁽²⁾	NA ⁽²⁾
P207889	750671	2085343	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
P207989	750671	2085330	Unit 2	20 46	5944 71	NA ⁽²⁾	NA ⁽²⁾
P208889	751086	2085249	Unit 3	92 50	5856 75	NA ⁽²⁾	NA ⁽²⁾
P208989	751044	2084839	Unit 2	17 85	5946 71	NA ⁽²⁾	NA ⁽²⁾
P209089	750566	2084910	Unit 2	26 58	5947 67	NA ⁽²⁾	NA ⁽²⁾
P209189	750762	2084309	Unit 2	14 06	5968 15	NA ⁽²⁾	NA ⁽²⁾
P209289 ⁽³⁾	750863	2084139	Unit 1	15 24	5968 18	NA ⁽²⁾	NA ⁽²⁾
P209389	750864	2084130	Unit 2	19 08	5964 31	NA ⁽²⁾	NA ⁽²⁾
P209489	750991	2084634	Unit 2	29 42	5950 68	NA ⁽²⁾	NA ⁽²⁾
P209589	751071	2085286	Unit 2	20 28	5929 76	NA ⁽²⁾	NA ⁽²⁾
P209689	750533	2085514	Unit 2	28 69	5935 74	NA ⁽²⁾	NA ⁽²⁾
P209789	750579	2085481	Unit 1	9 77	5955 17	NA ⁽²⁾	NA ⁽²⁾
P209889	751194	2084984	Unit 2	5 98	5936 42	NA ⁽²⁾	NA ⁽²⁾
P210089	751564	2084639	Unit 2	20 38	5880 02	NA ⁽²⁾	NA ⁽²⁾
P210189	750752	2084411	Unit 2	14 96	5967 52	NA ⁽²⁾	NA ⁽²⁾
P213889	750466	2086109	Unit 2	Drv	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
P213989	750468	2086102	Unit 1	Dry	NA ⁽²⁾	8 71	5947 67
P218089	749941	2084020	Unit 1	6 68	5980 87	NA ⁽²⁾	NA ⁽²⁾
P218389 ⁽³⁾	750831	2085648	Unit 1	14 79	5943 66	5 47	5952 98
P218789	749425	2086720	Unit 1	NA ⁽²⁾	NA ⁽²⁾	5 85	5958 67
P219089	751127	2084117	Unit 1 2	9 34	5940 56	NA ⁽²⁾	NA ⁽²⁾
P219189	751222	2084010	Unit 1	13 24	5929 91	12 68	5930 47
P219489 ⁽³⁾	750415	2085651	Unit 1	24 17	5936 98	NA ⁽²⁾	NA ⁽²⁾
P219589 ⁽³⁾	750268	2085536	Unit 2	27 61	5938 09	NA ⁽²⁾	NA ⁽²⁾
P314089	749461	2083653	Unit 1	NA ⁽²⁾	NA ⁽²⁾	7 95	5990 54
02191	749708	2086166	Unit 1	Drv	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
02291	749880	2086139	Unit 2	15 03	5923 23	4 97	5933 29
02391	749853	2086600	Unit 1	Dry	NA ⁽²⁾	NA ⁽²⁾	NA ⁽²⁾
02491	749949	2086432	Unit 2	17 49	5928 72	NA ⁽²⁾	NA ⁽²⁾
02691	750385	2086043	Unit 2	9 58	5926 8	NA ⁽²⁾	NA ⁽²⁾
2991	749777	2086970	Unit 3	NA ⁽²⁾	NA ⁽²⁾	8 79	5949 11
3391	750047	2086994	Unit 3	NA ⁽²⁾	NA ⁽²⁾	17 9	5928 32
7891	749653	2087041	Unit 1	NA ⁽²⁾	NA ⁽²⁾	7 79	5951 66
11891	750033	2086999	Unit 2	NA ⁽²⁾	NA ⁽²⁾	15 04	5932 4

APPENDIX A
RFEDS Ground Water Elevation Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Depth to Water (Top of Casing) (Feet)	September 1994 Ground Water Elevation (Feet)	2nd Quarter 1995 Depth to Water (Top of Casing) (Feet)	2nd Quarter 1995 Ground Water Elevation (Feet)
12191	749774	2086949	Unit 2	NA ⁽²⁾	NA ⁽²⁾	7 17	5951 02
20691	749411	2086317	Unit 1	NA ⁽²⁾	NA ⁽²⁾	7 92	5961 71
20791	749416	2086318	Unit 2	NA ⁽²⁾	NA ⁽²⁾	4 12	5965 37
46692	749554	2087077	Unit 3	NA ⁽²⁾	NA ⁽²⁾	41 05	5917 2
46792	749538	2087080	Unit 3	NA ⁽²⁾	NA ⁽²⁾	63 77	5894 67
46892	749524	2087087	Unit 3	NA ⁽²⁾	NA ⁽²⁾	98 36	5860 2
75892	750915	2086558	Unit 1	Drv	NA ⁽²⁾	0	5959 2
75992	750290	2086628	Unit 1	Dry	NA ⁽²⁾	4 62	5894 48
76192	750660	2086122	Unit 1	Drv	NA ⁽²⁾	6 45	5956 55
76292	750769	2085681	Unit 2	18 63	5940 67	5 15	5954 15
77392	752243	2084299	Unit 1	NA ⁽²⁾	NA ⁽²⁾	3 84	5961 66
77492	751246	2083508	Unit 1	NA ⁽²⁾	NA ⁽²⁾	11 93	5932 57
05093	750804	2085231	Unit 2	10 38	5955 16	3 47	5962 07
05193	750484	2085225	Unit 1	12 43	5958 15	6 28	5964 3
05293	750198	2084490	Unit 1	Dry	NA ⁽²⁾	5 88	5977 23
05393	750549	2085223	Unit 2	NA ⁽²⁾	NA ⁽²⁾	21 44	5948 25
22393	749564	2086121	Unit 3	NA ⁽²⁾	NA ⁽²⁾	117 49	5854 65
23293	749823	2086846	Unit 3	NA ⁽²⁾	NA ⁽²⁾	89 55	5868 47
40193 ⁽³⁾	751567	2085407	Unit 1	23 85	5880 8	23 26	5881 39
41193	751044	2084874	Unit 1	8 74	5953 78	3 34	5959 18
41693	750866	2084912	Unit 1	13 09	5962 16	12 48	5962 77
41993 ⁽³⁾	750874	2084283	Unit 2	14 92	5963 42	0	5978 34
42393	750804	2084286	Unit 1 2	NA ⁽²⁾	NA ⁽²⁾	10 14	5971 82
42993	750748	2084552	Unit 1	12 59	5968 16	7 9	5972 85
43293 ⁽³⁾	750826	2085753	Unit 2	16 88	5941 26	5 53	5952 61
43593	750612	2084456	Unit 2	9 12	5970 82	5 07	5974 87
43893	750453	2084655	Unit 1	13 05	5967 04	0	5980 09
43993	750486	2084909	Unit 1 2	13 59	5962 8	12 12	5964 27
44893 ⁽³⁾	751341	2085490	Unit 1	16 37	5911 46	17 94	5909 89
44993 ⁽³⁾	751332	2085514	Unit 1	15 48	5913 2	16 38	5912 3
45093	751315	2085546	Unit 1	Drv	NA ⁽²⁾	0	5929 86
45293 ⁽³⁾	751351	2085468	Unit 1	16 12	5910 86	0	5926 98
45393	751368	2085437	Unit 1	Drv	NA ⁽²⁾	9 84	5915 82
45593	751249	2084516	Unit 1 2	Drv	NA ⁽²⁾	0	5935 64
45693	751221	2084514	Unit 2	2 64	5936 17	2 21	5936 6
45793 ⁽³⁾	751139	2084528	Unit 1	7 05	5946 07	6 48	5946 64
45893	751113	2084467	Unit 2	18 94	5943 56	12 75	5949 75
45993	751138	2084512	Unit 2	7 29	5945 52	5 9	5946 91
46093	751247	2084888	Unit 1 2	Drv	NA ⁽²⁾	0	5933 91
46193	751219	2084858	Unit 2	7 99	5930 71	3 3	5935 4
46293	751180	2084859	Unit 1	5 79	5935 8	0	5941 59
46393	751573	2085418	Unit 1	20 90	5881 84	20 81	5881 93
46493	751558	2085394	Unit 1	Dry	NA ⁽²⁾	6 38	5899 19
10594	752124	2086746	Unit 1	NA ⁽²⁾	NA ⁽²⁾	6 08	5814 87

FOOTNOTES

(1) State Plane Coordinate System

(2) Data not available

(3) Water level below screened interval

APPENDIX B
Section 1
RFEDS Nitrate Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Nitrate Levels (mg/L)	1st Quarter 1995 Nitrate Levels (mg/L)
308-P-1	751968	2084165	Unit 2	NA ⁽³⁾	3 94
308-P-2	752052	2084580	Unit 2	NA ⁽³⁾	1 37
5074	751066	2084732	Unit 2	NA ⁽³⁾	NA ⁽³⁾
5174	751070	2084934	Unit 2	1128 40	NA ⁽³⁾
5274	751099	2085104	Unit 1,2	NA ⁽³⁾	NA ⁽³⁾
5374	750581	2086325	Unit 2	NA ⁽³⁾	NA ⁽³⁾
5474	751074	2086320	Unit 2	0 00	NA ⁽³⁾
5774	750822	2086075	Unit 2	0 00	NA ⁽³⁾
5874	751567	2085830	Unit 2	49 00	NA ⁽³⁾
5974	751815	2085580	Unit 1,2	7 00	NA ⁽³⁾
6074	752106	2085775	Unit 2	NA ⁽³⁾	NA ⁽³⁾
6174	752079	2085308	Unit 2	NA ⁽³⁾	NA ⁽³⁾
6274	751738	2085154	Unit 2	54 60	NA ⁽³⁾
6374	751806	2084589	Unit 2	2 80	NA ⁽³⁾
1386	751857	2086051	Unit 1	0 00	0 19
1486	751856	2085838	Unit 3	0 00	0 12
1586	751852	2085812	Unit 1	100 80	66 97
1686	751747	2085260	Unit 3	0 00	0 30
1786	751740	2085242	Unit 1	691 60	481 29
1886	751522	2085831	Unit 3	NA ⁽³⁾	NA ⁽³⁾
1986	750894	2083296	Unit 1	NA ⁽³⁾	0 28
2286	750718	2084411	Unit 1	14 00	5 94
2386	751522	2085831	Unit 1	1 40	NA ⁽³⁾
2486	750338	2084277	Unit 1	NA ⁽³⁾	NA ⁽³⁾
2586	750412	2084831	Unit 3	1 40	0 22
2686	750411	2084841	Unit 1	75 60	NA ⁽³⁾
2786	750781	2085238	Unit 3	14 00	0 73
2986	750599	2085687	Unit 1	NA ⁽³⁾	NA ⁽³⁾
3086	751078	2084921	Unit 2	631 40	523 16
3186	751051	2084764	Unit 2	NA ⁽³⁾	NA ⁽³⁾
3286	751050	2084743	Unit 3	0 00	0 62
3386	749950	2085003	Unit 1	NA ⁽³⁾	NA ⁽³⁾
3486	750162	2086193	Unit 3	0 00	0 01 ⁽²⁾
3586	750167	2086219	Unit 1	0 00	0 01 ⁽²⁾
3686	750387	2086820	Unit 1	NA ⁽³⁾	NA ⁽³⁾
4286	749559	2087114	Unit 1	NA ⁽³⁾	4 70
2187	749969	2085799	Unit 1	2 80	0 51
2287	749924	2085822	Unit 3	2 80	0 15
2587	749719	2086748	Unit 2	NA ⁽³⁾	6 87

APPENDIX B
Section 1
RFEDS Nitrate Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Nitrate Levels (mg/L)	1st Quarter 1995 Nitrate Levels (mg/L)
3887	750396	2085094	Unit 1	NA ⁽³⁾	NA ⁽³⁾
3987	751081	2085268	Unit 2	NA ⁽³⁾	1 14
5687	750638	2084423	Unit 2	203 00	NA ⁽³⁾
6587	752230	2083299	Unit 1	NA ⁽³⁾	7 66
6687	752150	2083325	Unit 1	NA ⁽³⁾	5 29
B206289	752253	2083564	Unit 2	NA ⁽³⁾	0 15
B208089	751143	2085876	Unit 1	0 00	0 48
B208189	751138	2085885	Unit 2	0 00	2 59
B208289	751739	2086289	Unit 2	46 20	NA ⁽³⁾
B208389	751687	2085584	Unit 2	91 00	NA ⁽³⁾
B208489	751683	2085636	Unit 2	NA ⁽³⁾	NA ⁽³⁾
B208589	751804	2085477	Unit 1	1114 40	NA ⁽³⁾
B208689	751728	2085250	Unit 2	0 00	0 43
B208789	751755	2084450	Unit 1	0 00	NA ⁽³⁾
B210389	751696	2085116	Unit 2	0 00	NA ⁽³⁾
B210489	751802	2085513	Unit 1	686 00	545 38
B213789	750538	2086677	Unit 1	NA ⁽³⁾	NA ⁽³⁾
P207389	750195	2084468	Unit 2	4.20	3.77
P207589	750395	2084843	Unit 2	4 20	NA ⁽³⁾
P207689	750398	2085318	Unit 1	51 80	7 55
P207789	750392	2085343	Unit 2	2 80	NA ⁽³⁾
P207889	750671	2085343	Unit 1	NA ⁽³⁾	NA ⁽³⁾
P207989	750671	2085330	Unit 2	12 60	4 00
P208889	751086	2085249	Unit 3	7 00	5 93
P208989	751044	2084839	Unit 2	1932 00	1544 47
P209089	750566	2084910	Unit 2	9 80	NA ⁽³⁾
P209189	750762	2084309	Unit 2	11 20	0 01 ⁽²⁾
P209289	750863	2084139	Unit 1	44 80	NA ⁽³⁾
P209389	750864	2084130	Unit 2	57 40	4 14
P209489	750991	2084634	Unit 2	305 20	152 71
P209489	750991	2084634	Unit 2	NA ⁽³⁾	155 84
P209589	751071	2085286	Unit 2	3836 00	4921 94
P209689	750533	2085514	Unit 2	82 60	38 56
P209789	750579	2085481	Unit 1	54 60	61 03
P209889	751194	2084984	Unit 2	2926 00	2309 48
P210089	751564	2084639	Unit 2	282 80	160 72
P210189	750752	2084411	Unit 2	30 80	12 44
P215789	749470	2083430	Unit 1	NA ⁽³⁾	5 36
P213889	750466	2086109	Unit 2	NA ⁽³⁾	NA ⁽³⁾
P213989	750468	2086102	Unit 1	NA ⁽³⁾	NA ⁽³⁾

APPENDIX B
Section 1
RFEDS Nitrate Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Nitrate Levels (mg/L)	1st Quarter 1995 Nitrate Levels (mg/L)
P218089	749941	2084020	Unit 1	0 00	NA ⁽³⁾
P218389	750831	2085648	Unit 1	35 00	NA ⁽³⁾
P219089	751127	2084117	Unit 1,2	0 00	NA ⁽³⁾
P219189	751222	2084010	Unit 1	0 00	NA ⁽³⁾
P219489	750415	2085651	Unit 1	71 40	NA ⁽³⁾
P219589	750268	2085536	Unit 2	162 40	NA ⁽³⁾
1391	2085226	749402	Unit 1	NA ⁽³⁾	0 43
1491	2085474	749430	Unit 2	NA ⁽³⁾	3 41
1791	2086018	749504	Unit 2	NA ⁽³⁾	4 70
1891	2086023	749438	Unit 2	NA ⁽³⁾	4 60
1991	2086734	749476	Unit 2	NA ⁽³⁾	2 57
02191	749708	2086166	Unit 1	NA ⁽³⁾	NA ⁽³⁾
2291	749880	2086139	Unit 2	14 00	6 98
02391	749853	2086600	Unit 1	NA	NA ⁽³⁾
2491	749949	2086432	Unit 2	5 60	2 00
02691	750385	2086043	Unit 2	22 40	NA ⁽³⁾
11891	750033	2086999	Unit 2	NA ⁽³⁾	5 24
12191	749774	2086949	Unit 2	NA ⁽³⁾	7 60
46692	749554	2087077	Unit 2	NA ⁽³⁾	0 15
46792	749538	2087080	Unit 2	NA ⁽³⁾	2 00
46892	749524	2087087	Unit 3	NA ⁽³⁾	0 02 ⁽²⁾
75892	750915	2086558	Unit 1	NA ⁽³⁾	NA ⁽³⁾
75992	750290	2086628	Unit 1	NA ⁽³⁾	1 10
76192	750660	2086122	Unit 1	NA ⁽³⁾	NA ⁽³⁾
76292	750769	2085681	Unit 2	42 00	26 00
77492	751246	2083508	Unit 1	NA ⁽³⁾	0 05 ⁽²⁾
05093	750804	2085231	Unit 2	1253 00	NA ⁽³⁾
05193	750484	2085225	Unit 1	368 20	NA ⁽³⁾
05293	750198	2084490	Unit 1	NA ⁽³⁾	NA ⁽³⁾
23293	749823	2086846	Unit 2	NA ⁽³⁾	3 19
40193	751567	2085407	Unit 1	1006 60	NA ⁽³⁾
41193	751044	2084874	Unit 1	862 40	NA ⁽³⁾
41693	750866	2084912	Unit 1	1806 00	NA ⁽³⁾
41993	750874	2084283	Unit 2	15 40	NA ⁽³⁾
42993	750748	2084552	Unit 1	1918 00	NA ⁽³⁾
43293	750826	2085753	Unit 2	36 40	NA ⁽³⁾
43593	750612	2084456	Unit 2	42 00	NA ⁽³⁾
43893	750453	2084655	Unit 1	99 40	NA ⁽³⁾

APPENDIX B
Section 1
RFEDS Nitrate Data

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Completion Zone	September 1994 Nitrate Levels (mg/L)	1st Quarter 1995 Nitrate Levels (mg/L)
43993	750486	2084909	Unit 1,2	302 40	NA ⁽³⁾
44893	751341	2085490	Unit 1	375 20	NA ⁽³⁾
44993	751332	2085514	Unit 1	21 00	NA ⁽³⁾
45093	751315	2085546	Unit 1	NA ⁽³⁾	NA ⁽³⁾
45293	751351	2085468	Unit 1	334 60	NA ⁽³⁾
45393	751368	2085437	Unit 1	NA ⁽³⁾	NA ⁽³⁾
45593	751249	2084516	Unit 1	NA ⁽³⁾	NA ⁽³⁾
45693	751221	2084514	Unit 2	852 60	NA ⁽³⁾
45793	751139	2084528	Unit 1	0 00	NA ⁽³⁾
45893	751113	2084467	Unit 2	886 20	NA ⁽³⁾
45993	751138	2084512	Unit 2	0 00	NA ⁽³⁾
46093	751247	2084888	Unit 1,2	NA ⁽³⁾	NA ⁽³⁾
46193	751219	2084858	Unit 2	1890 00	NA ⁽³⁾
46293	751180	2084859	Unit 1	1066 80	NA ⁽³⁾
46393	751573	2085418	Unit 1	924 00	NA ⁽³⁾
46493	751558	2085394	Unit 1	NA ⁽³⁾	NA ⁽³⁾

FOOTNOTES

- (1) State Plane Coordinate System
- (2) Data below detection limit
- (3) Data not available

APPENDIX B
Section 2
GSP Nitrate Data

Geoprobe Identification	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	2nd Quarter 1995 Nitrate Levels (mg/L)
GP20195	751854 7	2085824	5847 6	Unit 1	85 70
GP20295	751837 8	2085936	5844 2	Unit 1	0 16
GP20695	752031 9	2085588	5879 1	Unit 1	2 05
GP20795	751935 2	2085601	5857 9	Unit 1	NA ⁽²⁾
GP20995	751870 8	2085326	5864 8	Unit 1	0 31
GP21695	750328 3	2085220	5969 8	Unit 1	208 00
GP21795	750190 9	2085299	5967 7	Unit 1	0 53
GP22095	750400 1	2085327	5966 1	Unit 1	8 15
GP22195	750412 6	2085489	5962 0	Unit 1	6 24
GP22295	750744 3	2084406	5979 8	Unit 1	80 60
GP22695	750959 6	2084046	5980 1	Unit 1	NA ⁽²⁾
GP22995	751890 8	2086650	5840 3	Unit 1	1 40
GP23195	752143 4	2086584	5832 4	Unit 1	2 80
GP23395	750236 5	2086104	5916 8	Unit 1	11 70
GP23695	750727 2	2083854	5987 4	Unit 1	3 63
GP23895	750716 1	2084187	5982 5	Unit 1	0 77
GP24095	750047 4	2085537	5949 6	Unit 1	0 12
GP24295	750114 8	2085659	5944 0	Unit 1	0 11
GP24595	751905 4	2086441	5838 1	Unit 1	0 00
GP25295	751228	2084008	5941 0	Unit 1	2 00
GP25495	751650 9	2085290	5875 7	Unit 1	NA ⁽²⁾
GP25595	751616 5	2084846	5901 5	Unit 1	NA ⁽²⁾
GP25695	751596 7	2084746	5900 1	Unit 1	NA ⁽²⁾
GP25795	751662 7	2084826	5897 6	Unit 1	NA ⁽²⁾
GP25895	751707 3	2084831	5891 9	Unit 1	NA ⁽²⁾
GP259	751736 9	2085272	5867 2	Unit 1	182 40
GP260	750397 5	2085156	5972 6	Unit 1	15 60
GP261	750136 2	2085200	5968 9	Unit 1	1 67
GP262	750275 6	2085359	5967 3	Unit 1	9 61
GP263	750148 7	2085469	5965 3	Unit 1	0 19
GP279	751473 8	2085011	5907 5	Unit 1	1 75
GP281	751419 5	2085063	5918 4	Unit 1	NA ⁽²⁾
GP297	751944 9	2085738	5847 3	Unit 1	0 96
GP21095	751945 1	2085450	5868 4	Units 1,2	NA ⁽²⁾
GP21195	751922 8	2086613	5837 7	Units 1,2	NA ⁽²⁾
GP21295	751836 3	2085938	5844 3	Units 1,2	0 44
GP20395	751728 8	2086285	5851 8	Unit 2	NA ⁽²⁾
GP20495	751670 4	2086366	5857 4	Unit 2	7 70
GP20595	752064 3	2085330	5911 8	Unit 2	NA ⁽²⁾
GP20895	752109 7	2085788	5886 8	Unit 2	NA ⁽²⁾
GP21395	751729	2086287	5851 5	Unit 2	NA ⁽²⁾

APPENDIX B
Section 2
GSP Nitrate Data

Geoprobe Identification	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	2nd Quarter 1995 Nitrate Levels (mg/L)
GP21895	750063 5	2085359	5967 0	Unit 2	NA ⁽²⁾
GP21995	750263 6	2085544	5963 7	Unit 2	48 40
GP22395	750743 1	2084402	5979 8	Unit 2	67 80
GP22495	751010 2	2084186	5966 1	Unit 2	23 20
GP22595	750959 5	2084045	5980 2	Unit 2	NA ⁽²⁾
GP22795	750390 8	2084174	5985 9	Unit 2	4 70
GP22895	751889 2	2086650	5840 5	Unit 2	9 31
GP23095	752142 1	2086585	5832 1	Unit 2	13 00
GP23295	750398 7	2086046	5935 8	Unit 2	13 80
GP23495	750462 6	2086314	5930 0	Unit 2	0 20
GP23595	750726	2083854	5987 3	Unit 2	0 71
GP23795	750996 8	2084632	5977 4	Unit 2	104 00
GP23995	750047 3	2085538	5949 5	Unit 2	0 25
GP24195	750113 9	2085658	5943 9	Unit 2	0 60
GP24395	751175 2	2084303	5944 1	Unit 2	44 40
GP24495	751904 2	2086441	5838 4	Unit 2	0 33
GP24695	751872	2085327	5864 9	Unit 2	5 16
GP24795	750235 7	2086106	5916 5	Unit 2	11 90
GP24895	750986 2	2085468	5956 0	Unit 2	54 70
GP24995	751058 7	2085303	5949 2	Unit 2	1260 00
GP25095	751214 7	2084694	5936 5	Unit 2	114 00
GP25195	751220 2	2084432	5937 7	Unit 2	434 00
GP25395	751887 9	2085474	5857 9	Unit 2	0 88
GP264	751023 5	2085476	5952 0	Unit 2	5 80
GP265	751109	2085296	5944 3	Unit 2	NA ⁽²⁾
GP266	751284 2	2084671	5929 1	Unit 2	3 99
GP267	751285 8	2084467	5930 1	Unit 2	NA ⁽²⁾
GP268	750399 8	2085588	5960 7	Unit 2	0 68
GP269	751226 7	2085432	5936 2	Unit 2	47 10
GP270	751226 2	2085432	5936 2	Unit 2	2 60
GP271	751369 8	2086388	5900 2	Unit 2	NA ⁽²⁾
GP272	751650 5	2085291	5876 0	Unit 2	540 00
GP273	750038 3	2085704	5935 4	Unit 2	19 30
GP274	751784 1	2086311	5850 5	Unit 2	NA ⁽²⁾
GP275	751668 8	2086238	5861 2	Unit 2	NA ⁽²⁾
GP276	751749 1	2085740	5867 3	Unit 2	4 47
GP277	751478 8	2085015	5906 3	Unit 2	3 70
GP278	751503 7	2085548	5908 0	Unit 2	NA ⁽²⁾
GP280	751418 2	2085065	5918 4	Unit 2	NA ⁽²⁾
GP282	751762 6	2086358	5852 1	Unit 2	1 09
GP283	751678	2086272	5856 0	Unit 2	10 75

APPENDIX B
Section 2
GSP Nitrate Data

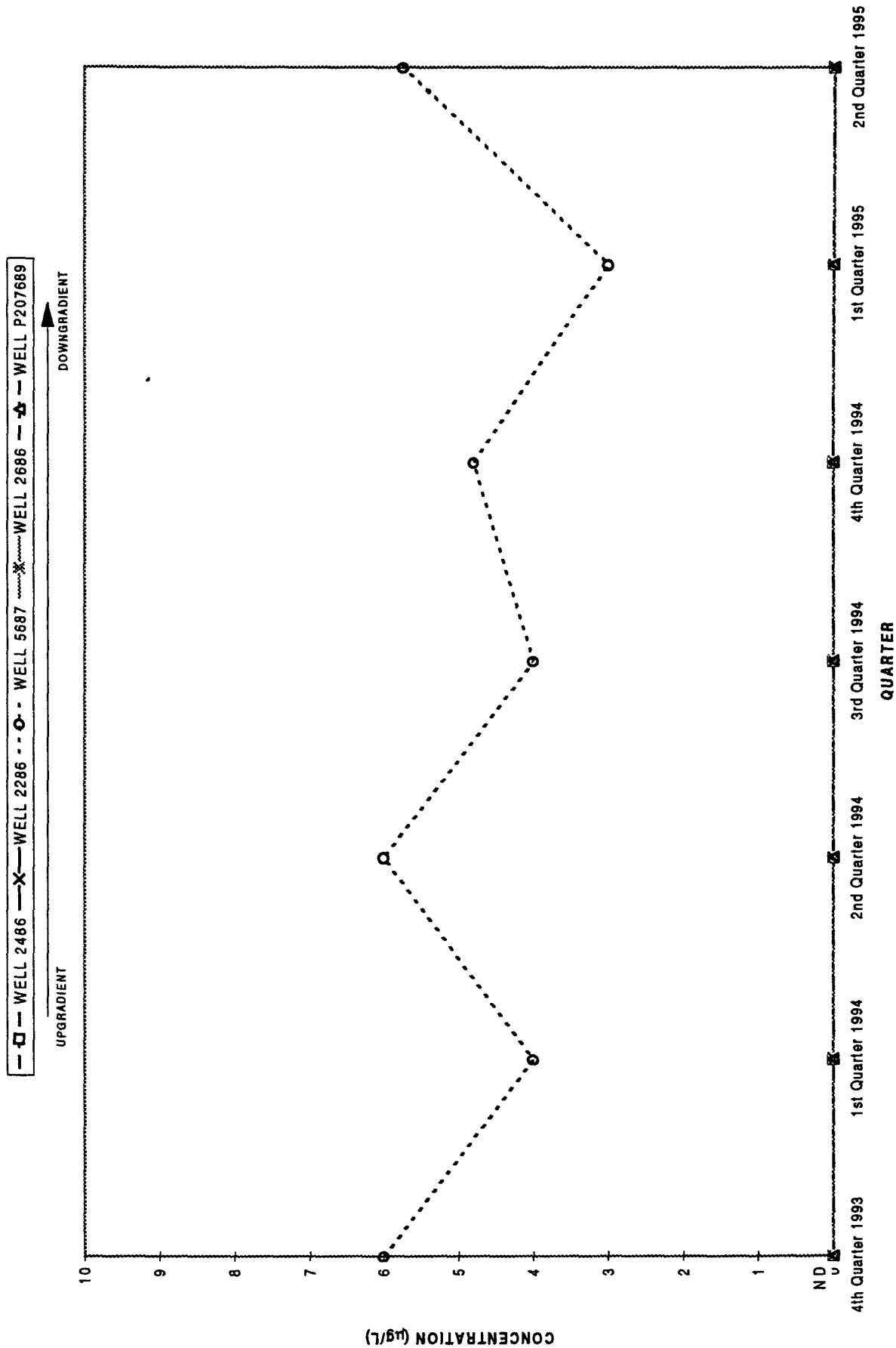
Geoprobe Identification	Northing Survey Coordinate ⁽¹⁾	Easting Survey Coordinate ⁽¹⁾	Geoprobe Survey Elevation (Feet)	Completion Zone	2nd Quarter 1995 Nitrate Levels (mg/L)
GP284	751260 7	2086009	5900 6	Unit 2	NA ⁽²⁾
GP285	751164 5	2085930	5923 5	Unit 2	0 20
GP286	750160 9	2085750	5940 3	Unit 2	19 70
GP287	750269 6	2085794	5945 3	Unit 2	NA ⁽²⁾
GP288	750412 1	2085802	5951 4	Unit 2	0 36
GP289	750148 8	2085468	5965 4	Unit 2	0 73
GP290	750853 8	2085788	5953 1	Unit 2	4 47
GP291	751066 2	2085386	5948 5	Unit 2	NA ⁽²⁾
GP292	751196 4	2085114	5936 9	Unit 2	185 00
GP293	751249 7	2084237	5934 6	Unit 2	136 00
GP294	751913 6	2085273	5878 8	Unit 2	NA ⁽²⁾
GP295	751087 1	2085755	5943 6	Unit 2	5 62
GP296	751283 8	2086297	5905 1	Unit 2	0 99
GP298	751455 7	2086192	5873 0	Unit 2	NA ⁽²⁾
GP299	751665 9	2085551	5878 1	Unit 2	NA ⁽²⁾
GP300	751595 3	2084745	5899 8	Unit 2	34 80
GP301	751662	2084826	5897 7	Unit 2	NA ⁽²⁾
GP302	751705 5	2084831	5892 1	Unit 2	0 53
GP303	751617 3	2084846	5901 4	Unit 2	NA ⁽²⁾
GP304	751485 2	2084808	5912 8	Unit 2	NA ⁽²⁾
GP305	751497 2	2084617	5910 4	Unit 2	203 00
GP306	751450 7	2084487	5920 8	Unit 2	16 90
GP307	751473 2	2085135	5912 0	Unit 2	NA ⁽²⁾
GP308	751442 7	2085222	5915 1	Unit 2	NA ⁽²⁾

FOOTNOTES

(1) State Plane Coordinate System

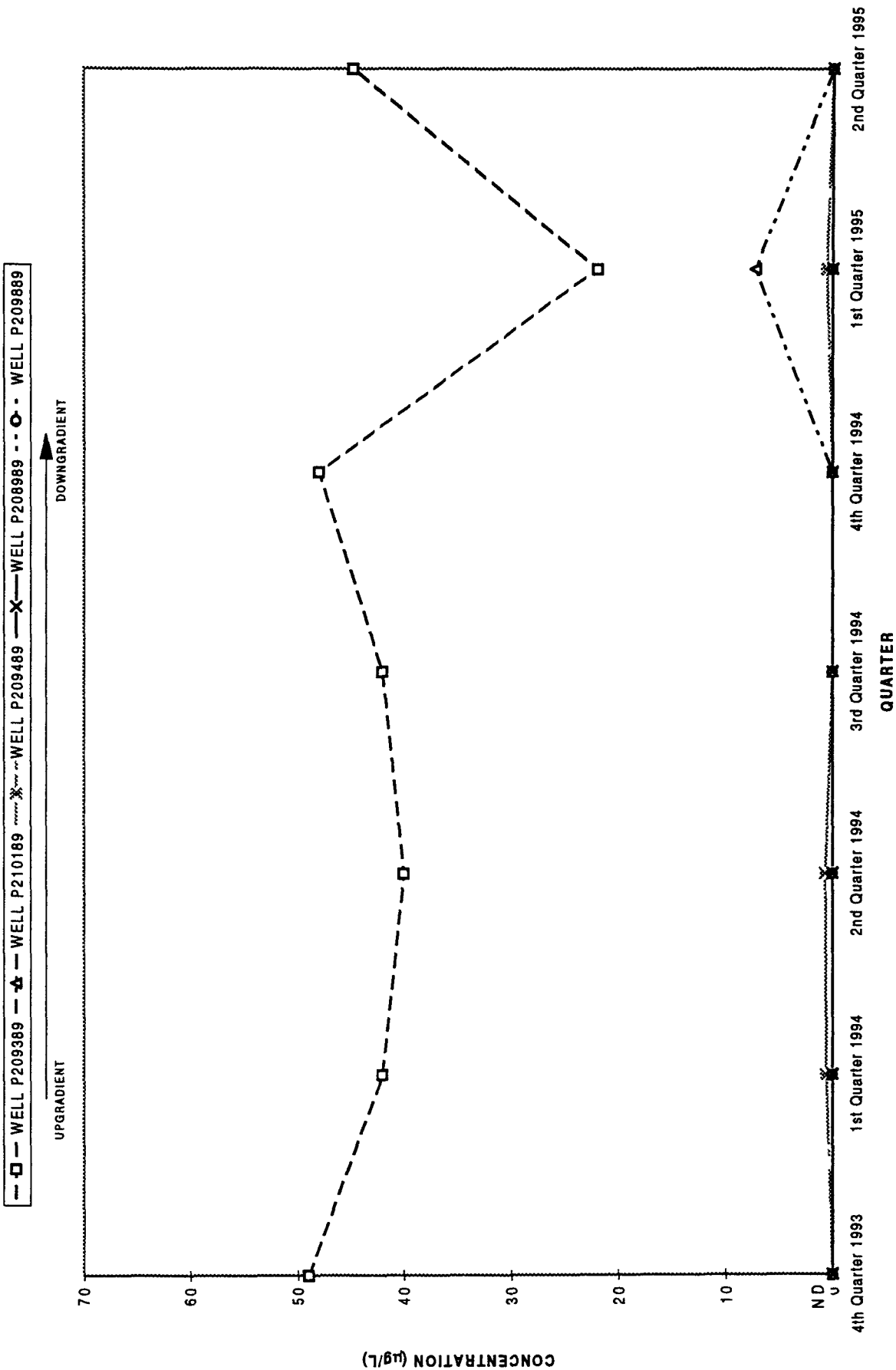
(2) Data not available

FIGURE C-1
CONCENTRATION vs TIME
UNIT 1 - 1,1-DICHLOROETHENE



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FIGURE C-2
CONCENTRATION vs TIME
UNIT 2 - 1,1-DICHLOROETHENE



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APPENDIX C

FIGURE C-3
CONCENTRATION vs TIME
UNIT 1 - CHLOROFORM

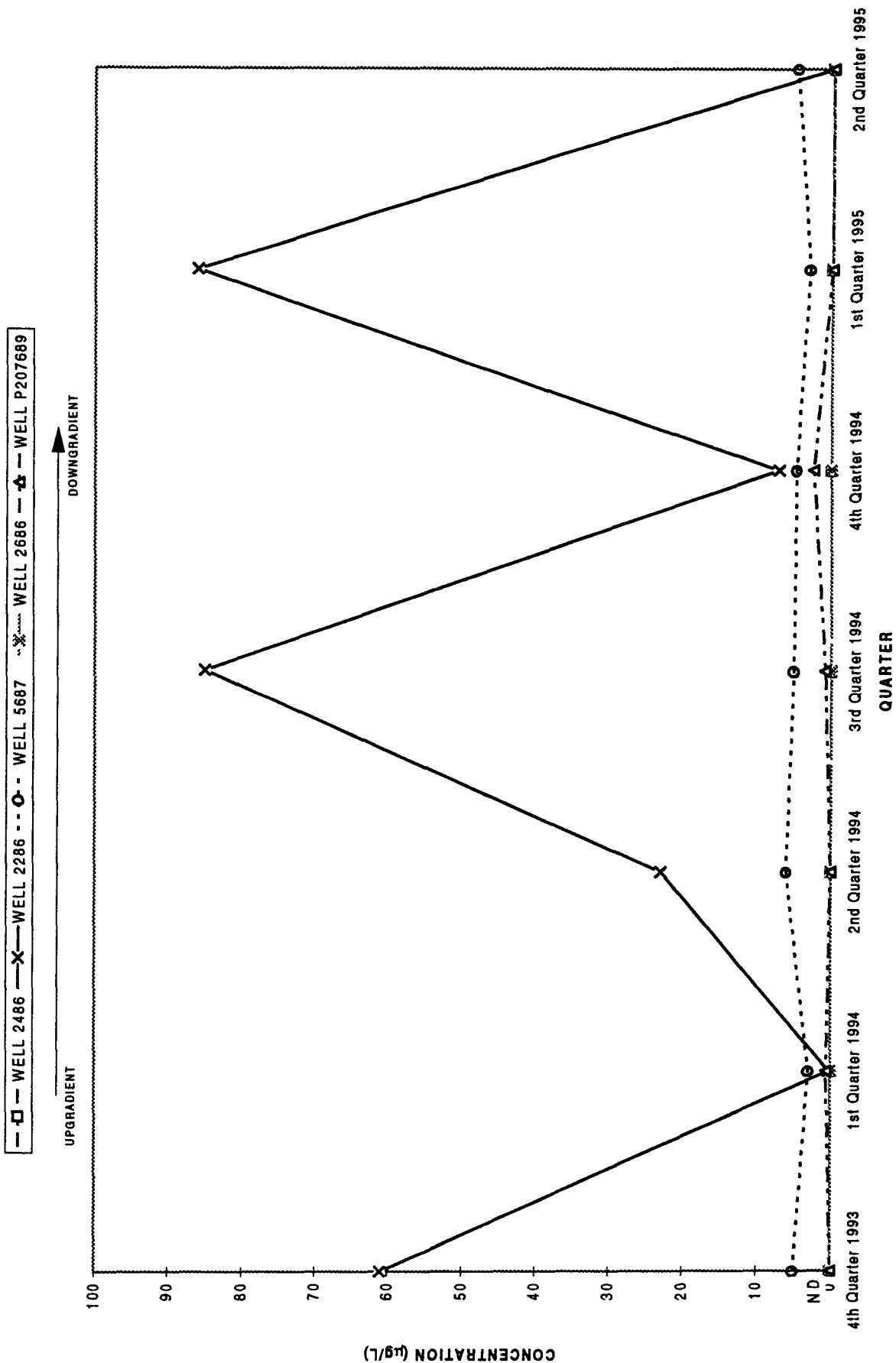


FIGURE C-4
CONCENTRATION vs TIME
UNIT 2 - CHLOROFORM

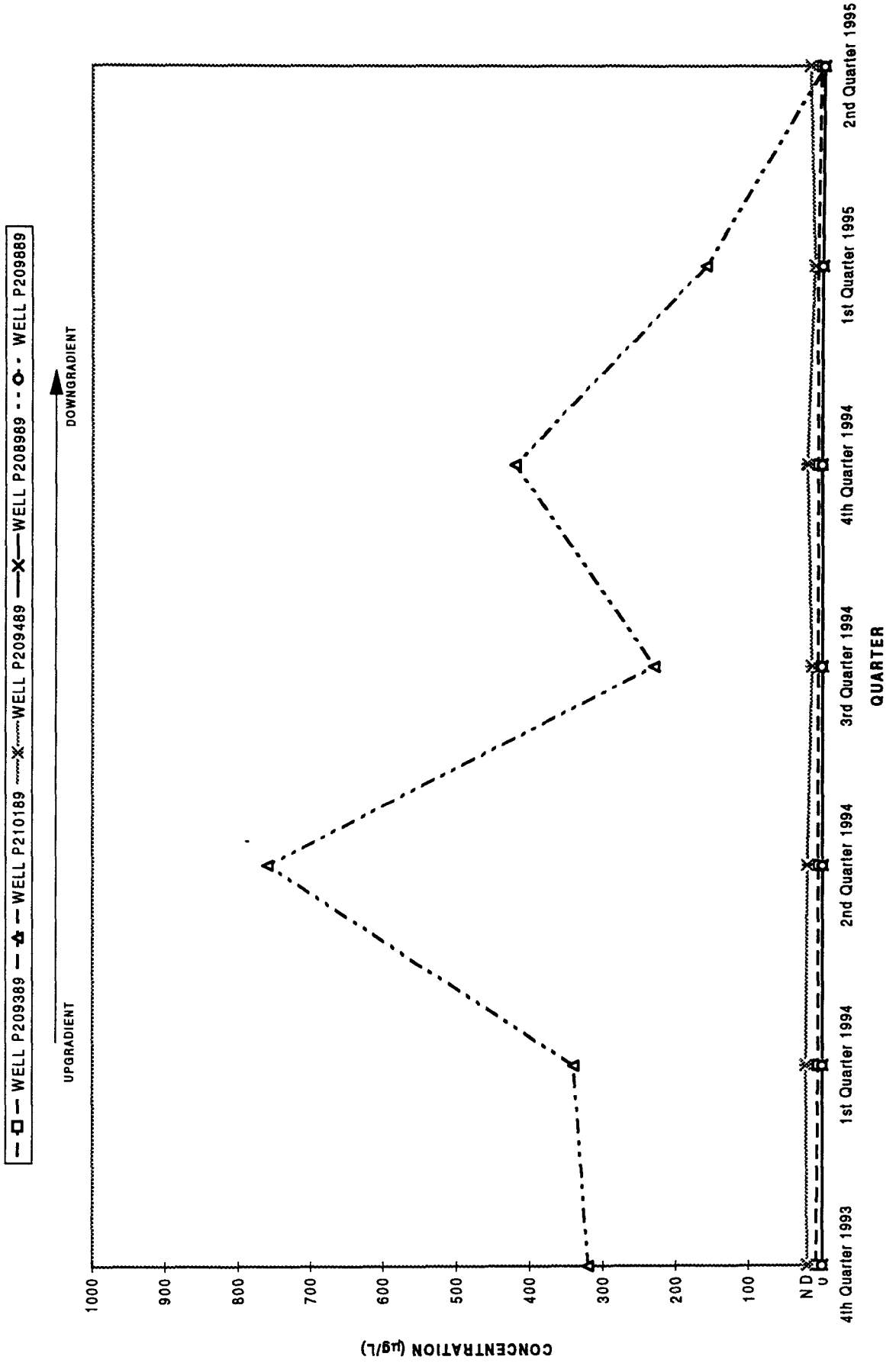


FIGURE C-5
CONCENTRATION vs TIME
UNIT 1 - TRICHLOROETHENE

---□--- WELL 2486 ---X--- WELL 2286 ---O--- WELL 5687 ---X--- WELL 2686 ---☆--- WELL P207689

UPGRADIENT
DOWNGRADIENT

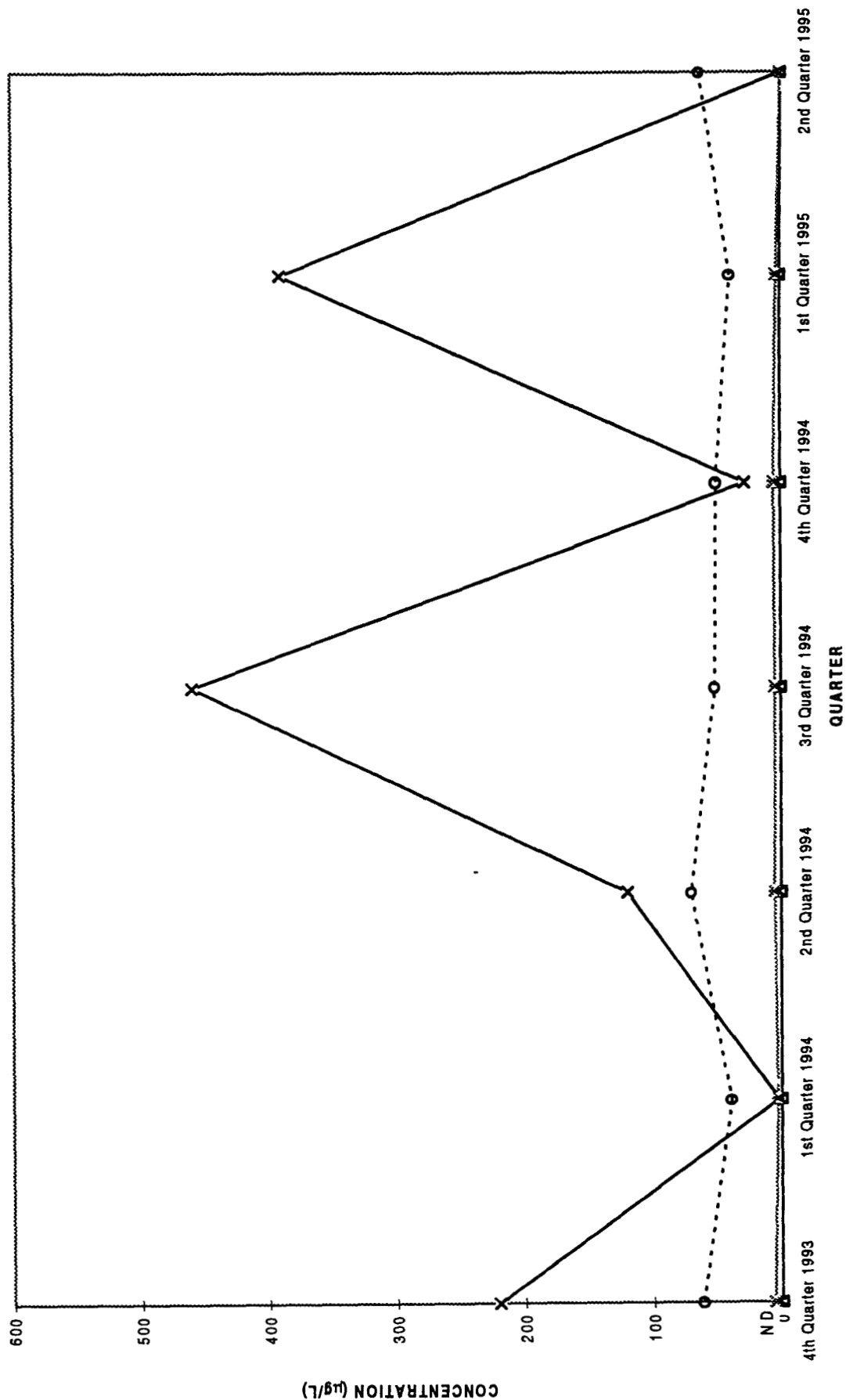


FIGURE C-6
CONCENTRATION vs TIME
UNIT 2 - TRICHLOROETHENE

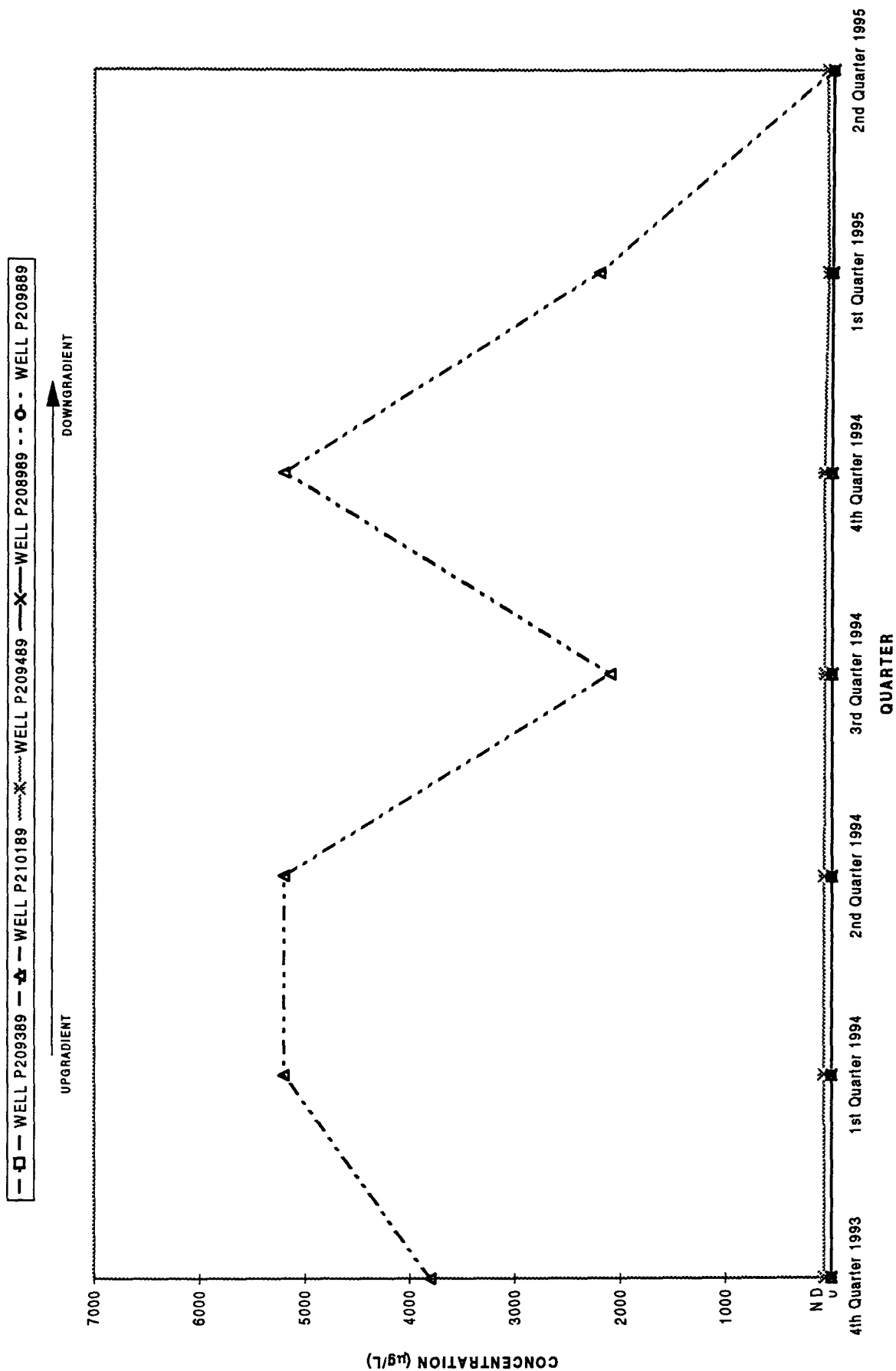


FIGURE C-7
CONCENTRATION vs TIME
UNIT 1 - TETRACHLOROETHENE

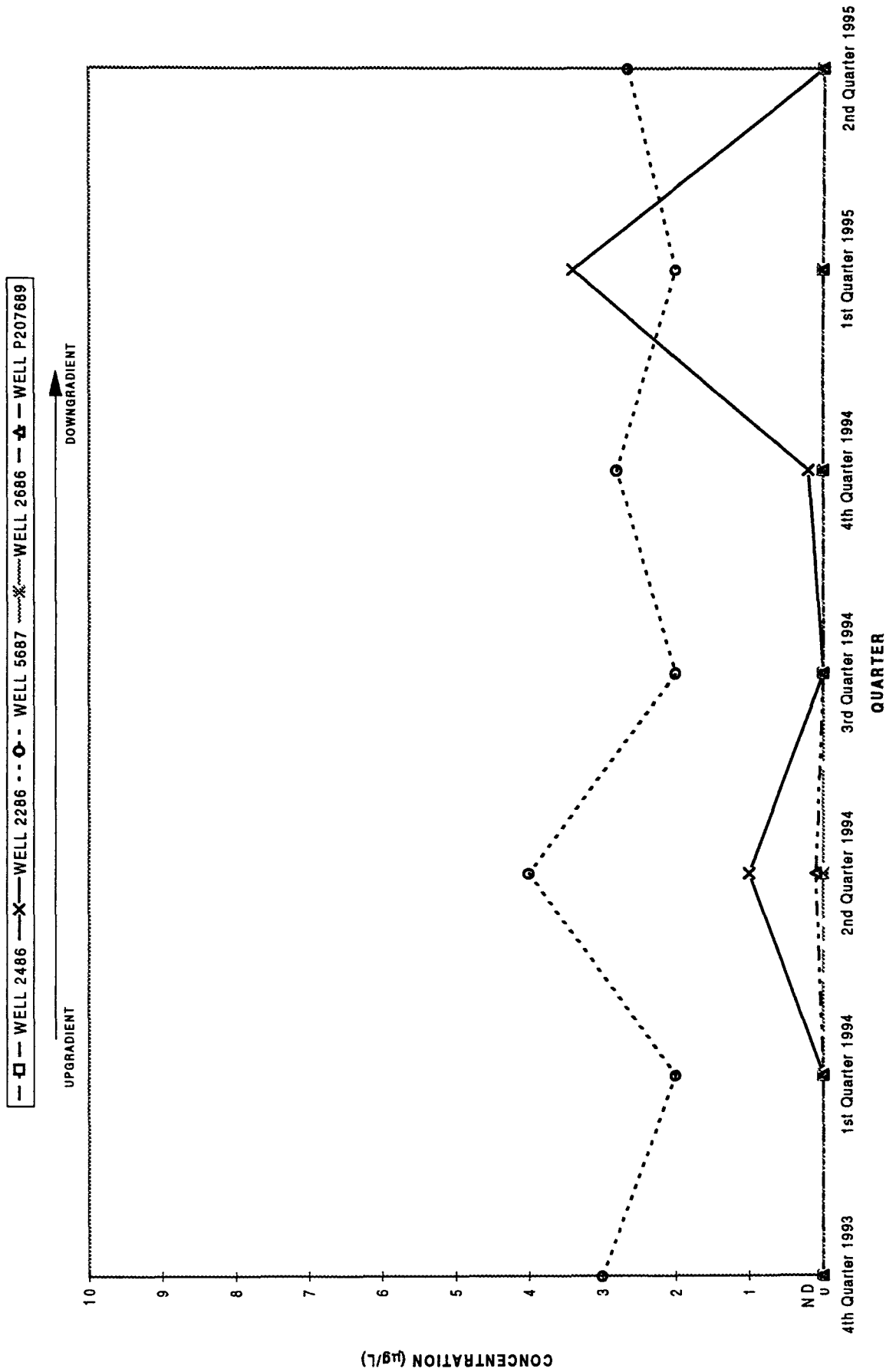
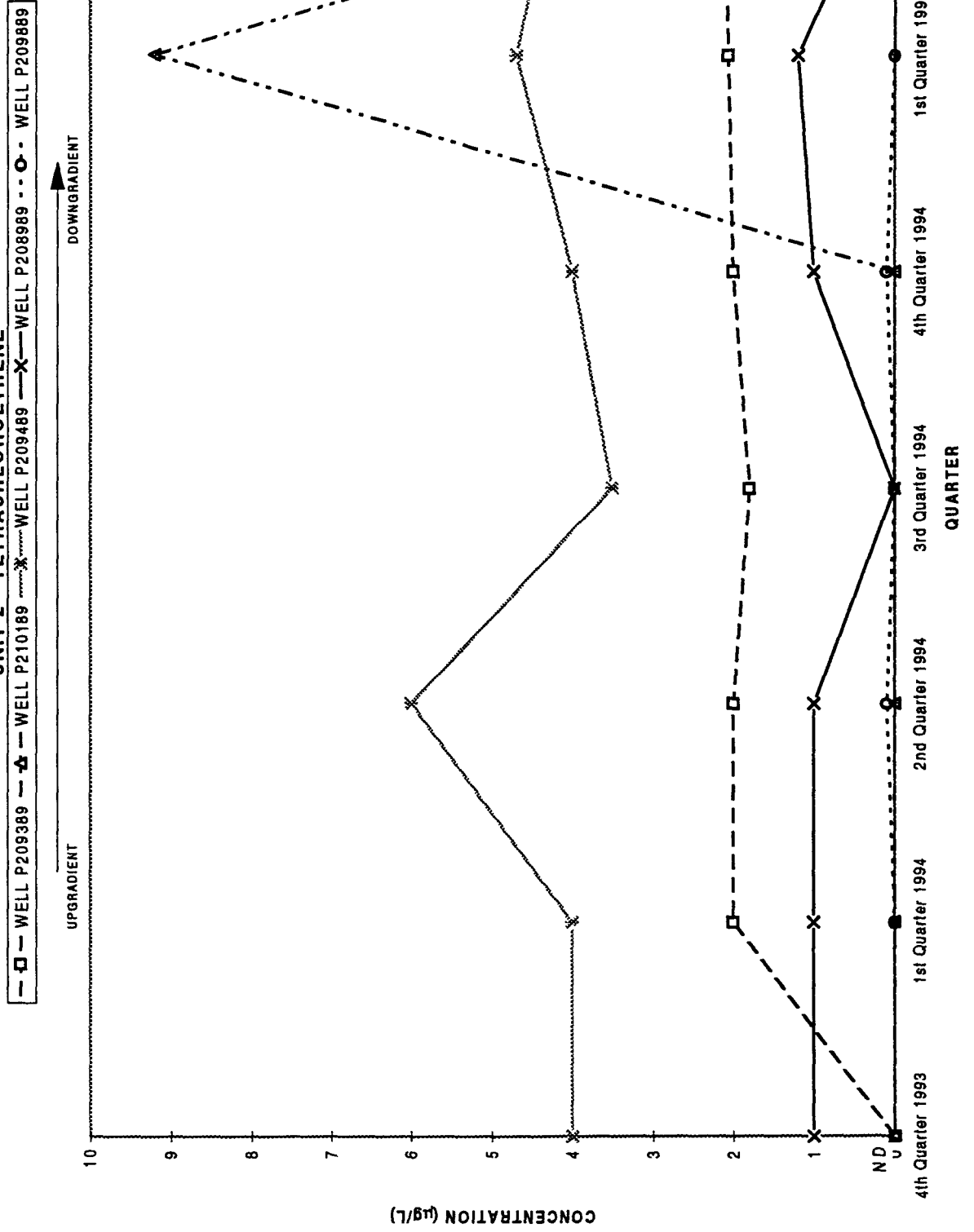


FIGURE C-8
CONCENTRATION vs TIME
UNIT 2 - TETRACHLOROETHENE



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APPENDIX C

FIGURE C-9
CONCENTRATION vs TIME
UNIT 1 - CARBON TETRACHLORIDE

--- □ --- WELL 2486 --- X --- WELL 2286 - - - ○ - - WELL 5687 X WELL 2686 -- ▲ -- WELL P207689

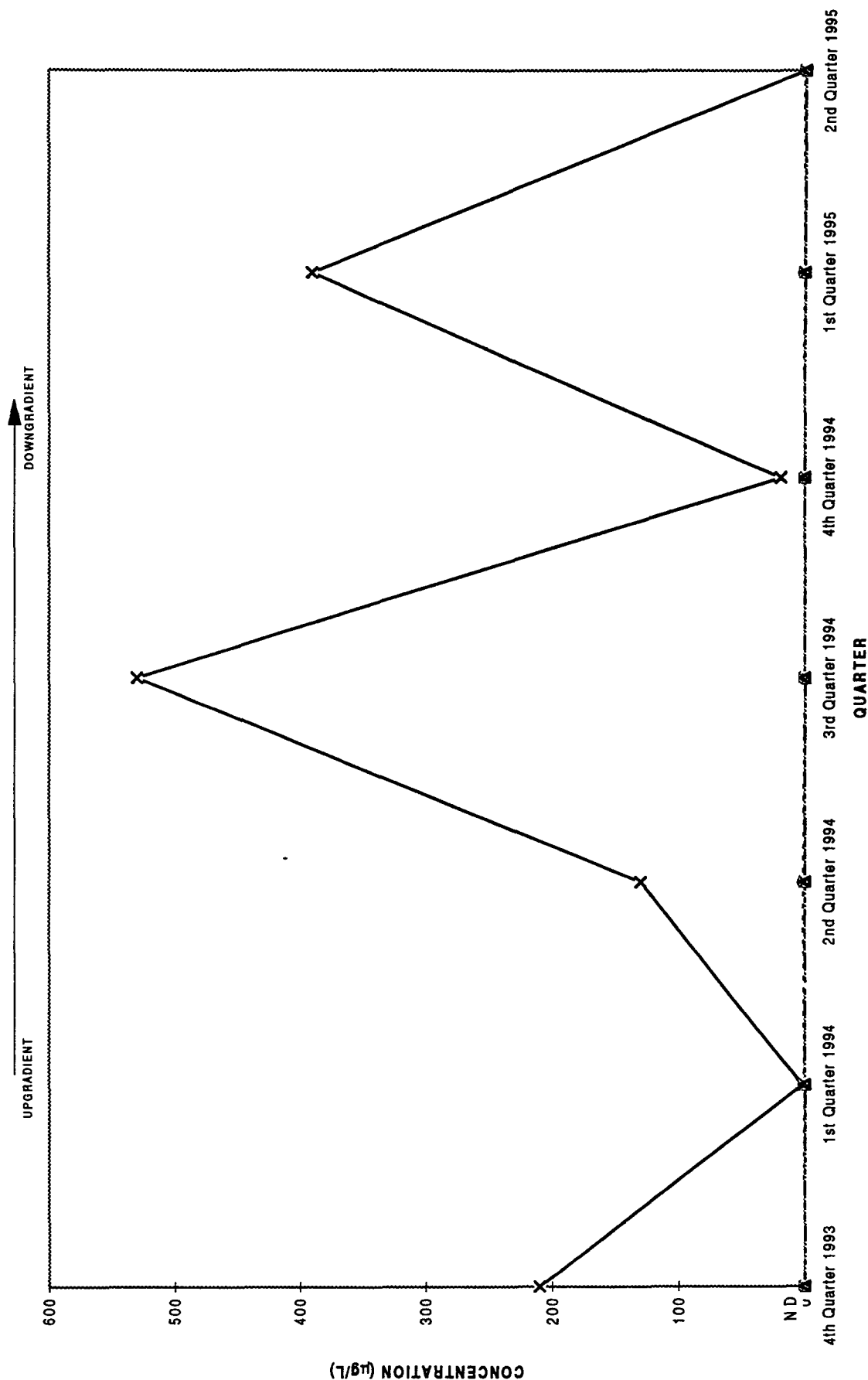
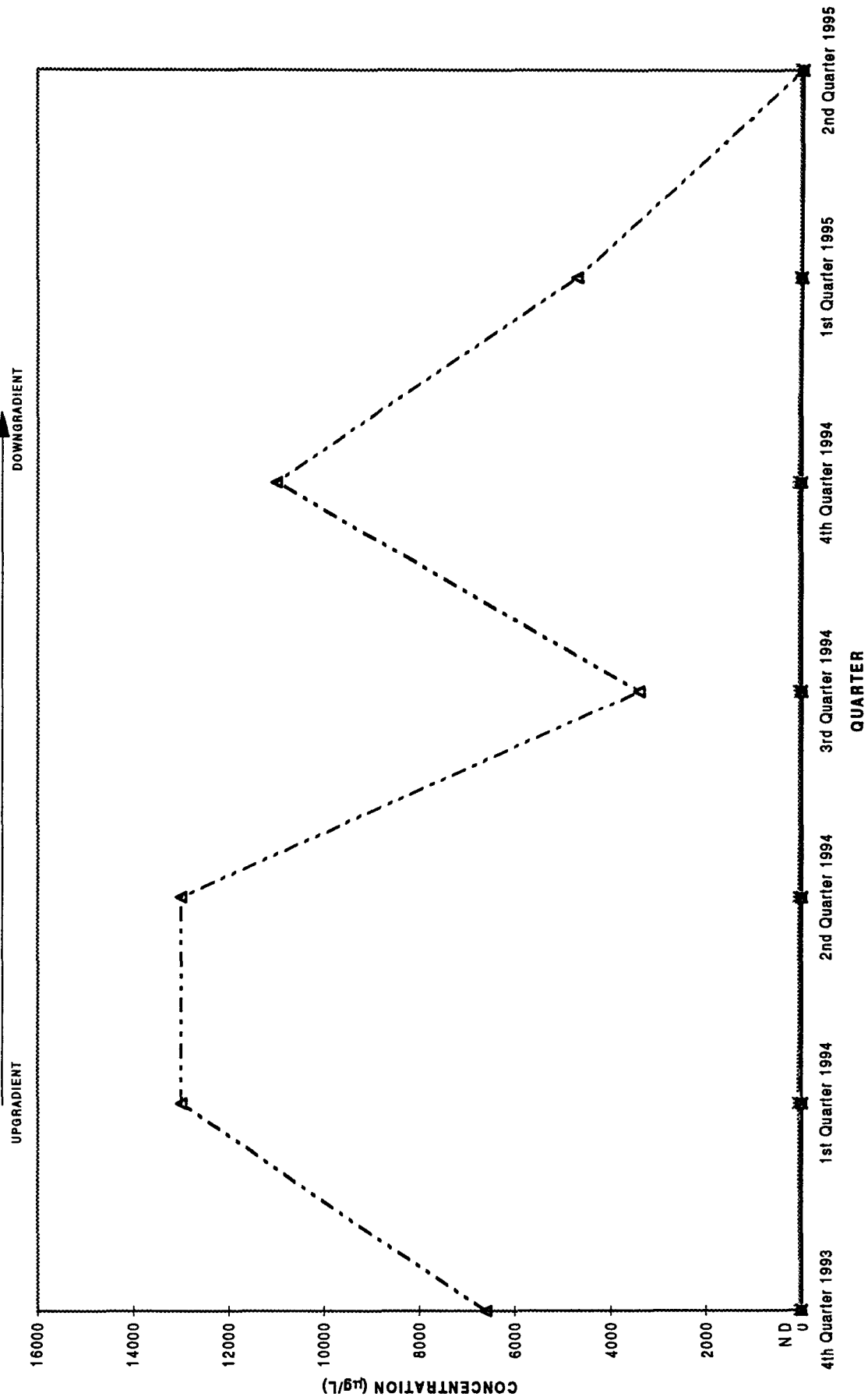


FIGURE C-10
CONCENTRATION vs TIME
UNIT 2 - CARBON TETRACHLORIDE

---□--- WELL P209389 --△-- WELL P210189X..... WELL P209489 ---X--- WELL P208989 - - - ○ - - WELL P209889



1st Quarter 1995

RFEDS Radionuclide Data ⁽¹⁾

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Eastings Survey Coordinate ⁽¹⁾	Completion Zone	Uranium-238 Levels (pCi/L)	Uranium-235 Levels (pCi/L)	Uranium-233/234 Levels (pCi/L)	Tritium Levels (pCi/L)	Total Radio-Cesium Levels (pCi/L)	Strontium-89/90 Levels (pCi/L)	Radium 226 Levels (pCi/L)	Plutonium-239/240 Levels (pCi/L)	Gross Beta Levels (pCi/L)	Gross Alpha Levels (pCi/L)
308 P 1	751968	2084165 03	Unit 2	11 83	1 07	18 98	<263	0 09	<0 51	0 28	NA (2)	18 70	19 97
308 P 2	752052	2084580 23	Unit 2	17 49	1 64	21 99	<265	0 23	<0 52	0 73	0 003	18 45	25 88
1386	751857	2086051	Unit 1	8 26	1 70	10 37	<244	NA (2)	NA (2)	0 30	<0 009	7 34	5 55
1486	751857	2086051	Unit 3	0 31	0 14	1 15	<252	0 66	<0 78	0 26	<0 011	7 67	0 56
1586	751852	2085812	Unit 1	15 99	2 91	19 74	85 51	0 56	<0 82	0 51	0 003	8 30	22 55
1586	751852	2085812	Unit 1	NA (2)	NA (2)	NA (2)	169 67	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
1686	751747	2085260	Unit 3	<0 36	0 03	0 29	<360	0 32	0 51	NA (2)	<0 027	9 00	1 10
1786	751740	2085242	Unit 1	34 00	1 10	46 00	540 00	0 92	0 84	NA (2)	<0 056	12 00	42 00
1986	750894	2083296	Unit 1	1 80	0 10	2 20	9 40	0 81	0 14	NA (2)	0 00	2 50	4 10
1986	750894	2083296	Unit 1	3 20	0 08	3 10	NA (2)	0 97	0 20	1 70	<0 048	19 00	22 00
2286	750718	2084411	Unit 1	2 39	0 27	7 77	251 61	NA (2)	NA (2)	0 43	NA (2)	13 63	10 27
2586	750412	2084831	Unit 3	1 97	0 91	4 22	<245	0 55	<0 82	0 55	NA (2)	7 85	9 84
2786	750781	2085218	Unit 3	NA (2)	NA (2)	NA (2)	131 30	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
3086	751078	2084921	Unit 2	24 36	2 47	37 09	1583 00	NA (2)	NA (2)	1 13	0 00	52 27	99 55
3286	751050	2084743	Unit 3	0 24	0 04	0 48	4 60	<1 2	0 07	NA (2)	0 00	2 90	1 10
3486	750162	2086191	Unit 3	0 20	0 04	0 10	<1 4	<1 4	0 12	NA (2)	<0 015	9 10	2 40
3586	750167	2086219	Unit 1	2 25	0 41	2 50	269	0 15	<0 40	0 20	0 00	0 65	6 06
4286	749559	2087114	Unit 1	1 40	0 03	3 00	380 00	0 44	0 12	NA (2)	0 07	0 18	9 00
2187	749969	2085799	Unit 1	18 32	1 93	25 98	81 23	NA (2)	NA (2)	0 41	NA (2)	14 41	27 42
2287	749924	2085822	Unit 3	0 32	0 08	1 45	<272	0 17	<0 33	0 51	0 004	6 82	1 72
2587	749719	2086748	Unit 2	1 80	0 04	3 10	440 00	0 25	0 18	NA (2)	0 002	0 24	4 50
3987	751081	2085268	Unit 2	NA (2)	NA (2)	NA (2)	110 00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
5687	750638	2084423	Unit 1	NA (2)	NA (2)	NA (2)	1240 00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
6587	752230	2083299	Unit 1	1 50	0 72	2 23	93 04	0 29	0 13	NA (2)	0 001	1 64	<1 62
6587	752230	2083299	Unit 1	NA (2)	NA (2)	2 23	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
6687	752150	2083325	Unit 1	0 85	0 29	1 35	128 81	NA (2)	NA (2)	0 59	NA (2)	5 00	10 73
6687	752150	2083325	Unit 1	NA (2)	NA (2)	1 35	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
B206289	752253	2083564	Unit 2	0 86	0 21	2 58	<258	NA (2)	NA (2)	NA (2)	NA (2)	3 05	2 40
B208089	751143	2085876	Unit 1	NA (2)	NA (2)	NA (2)	157 38	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
B208189	751138	2085885	Unit 2	6 37	0 59	9 11	216 97	NA (2)	NA (2)	0 54	NA (2)	2 64	7 31
B208189	751138	2085885	Unit 2	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	2 64	NA (2)
B208689	751728	2085250	Unit 2	42 00	1 00	69 00	<360	NA (2)	NA (2)	NA (2)	NA (2)	33 00	92 00
B210489	751802	2085513	Unit 1	30 95	5 61	36 27	573 11	0 35	<0 95	0 39	<0 0031	17 80	67 13
P207389	750195	2084468	Unit 2	2 10	0 07	4 60	310 00	0 49	<0 28	NA (2)	<0 043	2 80	5 50
P207689	750398	2085318	Unit 1	4 49	1 58	6 39	83 55	0 24	<0 78	<0 23	<0 015	1 51	17 86
P207989	750671	2085330	Unit 2	NA (2)	NA (2)	NA (2)	<340	NA (2)	NA (2)	7 30	0 03	26 00	NA (2)
P208889	751086	2085249	Unit 3	NA (2)	NA (2)	NA (2)	<360	2 60	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
P208989	751044	2084839	Unit 2	36 00	1 80	60 00	2100 00	0 00	4 00	NA (2)	NA (2)	NA (2)	110 00
P209189	750762	2084309	Unit 2	3 60	0 08	3 00	410 00	0 25	0 02	0 39	0 16	13 00	6 00
P209389	750864	2084130	Unit 2	0 12	0 12	0 43	206 37	0 17	<0 18	1 07	0 00	4 31	1 73
P209489	750991	2084614	Unit 2	25 04	2 44	29 64	915 40	<0 67	0 10	0 50	<0 011	74 57	52 11
P209589	751071	2085286	Unit 2	NA (2)	NA (2)	NA (2)	11349 56	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)

RFEDS Radionuclide Data ⁽¹⁾

RCRA Well ID	Northing Survey Coordinate ⁽²⁾	Easting Survey Coordinate ⁽²⁾	Completion Zone	Uranium-238 Levels (pCi/L)	Uranium-235 Levels (pCi/L)	Uranium-233/234 Levels (pCi/L)	Tritium Levels (pCi/L)	Total Radio- Cesium Levels (pCi/L)	Strontium-89/90 Levels (pCi/L)	Radium-226 Levels (pCi/L)	Plutonium-239/240 Levels (pCi/L)	Gross Beta Levels (pCi/L)	Gross Alpha Levels (pCi/L)
P209789	750579	2085481	Unit 1	5.19	0.40	7.96	613.63	<0.68	<0.43	0.26	0.00	2.90	7.39
P209889	751194	2084984	Unit 2	21.00	0.70	27.00	5100.00	3.10	2.80	NA (2)	<0.43	31.00	82.00
P210089	751564	2084639	Unit 2	2.39	0.47	3.78	0.00	0.46	<0.90	0.44	NA (2)	79.23	13.89
P210189	750752	2084411	Unit 2	1.49	0.04	2.22	628.84	0.04	<0.35	0.59	0.01	5.77	3.17
P215789	749470	2083430	Unit 1	0.58	0.15	0.96	89.08	0.04	0.06	NA (2)	0.00	1.28	0.24
P215789	749470	2083430	Unit 1	2.14	0.14	1.87	NA (2)	NA (2)	0.15	2.21	0.002	67.29	40.48
P219189	751222	2084010	Unit 1	NA (2)	NA (2)	NA (2)	860.00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
P219489	750415	2085651	Unit 1	NA (2)	NA (2)	NA (2)	310.00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
P219589	750268	2085556	Unit 2	NA (2)	NA (2)	NA (2)	503.59	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
01391	749402	2085226	Unit 1	4.90	0.18	4.00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	4.10	6.70
01891	749438	2086023	Unit 2	1.80	0.10	3.30	NA (2)	0.18	0.10	NA (2)	NA (2)	3.50	6.30
01991	749476	2086734	Unit 2	1.50	<0.66	1.30	62.00	0.13	<0.30	NA (2)	0.00	2.60	5.00
02291	749880	2086139	Unit 2	3.00	0.12	7.10	360.00	0.10	0.11	NA (2)	0.00	1.00	7.90
02491	749949	2086432	Unit 2	3.20	0.15	3.90	NA (2)	0.36	0.06	NA (2)	NA (2)	3.20	6.10
11891	750033	2086999	Unit 2	1.60	0.00	2.60	410.00	1.50	0.06	NA (2)	0.02	3.10	4.60
46792	749518	2087080	Unit 2	1.10	0.11	1.80	NA (2)	0.23	0.23	NA (2)	NA (2)	2.80	6.10
77492	751246	2083508	Unit 1	3.01	0.12	3.21	45.78	NA (2)	NA (2)	1.76	0.004	28.38	25.55
05393	750549	2085223	Unit 2	NA (2)	NA (2)	NA (2)	160.00	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)
27293	749823	2086846	Unit 2	NA (2)	NA (2)	NA (2)	<.140	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)	NA (2)

FOOTNOTES

(1) Bolded values are total concentrations. All other results are dissolved fractions only.

(2) Data not available

(3) State Plane Coordinate System

RCRA Well ID	Northing Survey Coordinate ⁽²⁾	Easting Survey Coordinate ⁽²⁾	Completion Zone	1,1-Dichloroethylene Levels (ug/L)	Qual Code	Carbon Tetrachloride Levels (ug/L)	Qual Code	Chloroform Levels (ug/L)	Qual Code	Tetrachloroethylene Levels (ug/L)	Qual Code	Trichloroethylene Levels (ug/L)	Qual Code
308 P-1	751968	2084165 03	Unit 2	<0.5	U	1.49	U	<0.5	U	<0.5	U	0.87	U
308 P-1	751968	2084165 03	Unit 2	<0.5	U	1.50	U	<0.5	U	<0.5	U	0.87	U
308 P-2	752052	2084580 23	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
308 P-2	752052	2084580 23	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1386	751857	2086051	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1386	751857	2086051	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1486	751856	2085838	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1486	751856	2085838	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1586	751852	2085812	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1686	751747	2085260	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1686	751747	2085260	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
1786	751740	2085242	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	1.28	U
1786	751740	2085242	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	1.30	U
1786	751740	2085242	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	1.00	U
1986	750894	2083296	Unit 1	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
2286	750718	2084411	Unit 1	<0.5	U	390.00	D	75.00	E	25.00	E	170.00	U
2286	750718	2084411	Unit 1	<0.5	U	391.50	D	75.12	E	25.00	E	172.64	U
2286	750718	2084411	Unit 1	25.00	U	52.00	E	86.00	D	3.40	D	390.00	D
2286	750718	2084411	Unit 1	25.00	U	52.11	E	86.00	D	3.43	D	391.50	D
2286	750718	2084411	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2386	750338	2084259	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2486	750338	2084277	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2586	750412	2084831	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2686	750411	2084841	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	3.10	U
2786	750781	2085238	Unit 3	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
2786	750781	2085238	Unit 3	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
3086	751078	2084921	Unit 2	<0.5	U	<0.5	U	<0.5	U	1.76	U	0.75	U
3086	751078	2084921	Unit 2	<0.5	U	<0.5	U	<0.5	U	1.80	U	0.75	U
3286	751050	2084743	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3486	750162	2086193	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3486	750162	2086193	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3586	750167	2086219	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3586	750167	2086219	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3586	750167	2086219	Unit 1	7.50	U	7.50	U	7.50	U	7.50	U	7.50	U
3586	750167	2086219	Unit 1	7.50	U	7.50	U	7.50	U	7.50	U	7.50	U
4286	749559	2087114	Unit 1	1.00	U	160.00	U	7.00	U	34.00	U	16.00	U
4286	749559	2087114	Unit 1	1.00	U	170.00	U	7.00	U	35.00	U	21.00	U
2187	749969	2085799	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2187	749969	2085799	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2287	749924	2085822	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U

1st Quarter 1995
RFEDS Key VOC Data ⁽¹⁾

RCRA Well ID	Northing Survey Coordinate ⁽¹⁾	Eastings Survey Coordinate ⁽¹⁾	Completion Zone	1,1-Dichloroethylene Levels (ug/L)	Qual Code	CarbonTetrachloride Levels (ug/L)	Qual Code	Chloroform Levels (ug/L)	Qual Code	Tetrachloroethylene Levels (ug/L)	Qual Code	Trichloroethylene Levels (ug/L)	Qual Code
2287	749924	2085822	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
2587	749719	2086748	Unit 2	<0.5	U	53.80	D	2.00	D	102.50	D	19.60	D
2587	749719	2086748	Unit 2	5.00	U	88.47	E	5.00	E	93.48	E	31.19	E
3987	751081	2085268	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
3987	751081	2085268	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
5687	750638	2084423	Unit 1	3.00	U	<0.2	J	3.00	J	2.00	U	39.00	U
5687	750638	2084423	Unit 1	5.23	D	0.63	U	4.81	D	2.66	U	58.11	E
5687	750638	2084423	Unit 1	5.74	U	5.00	U	5.14	U	5.00	U	62.90	D
6587	752230	2083299	Unit 1	8.30	U	0.76	U	0.64	U	1.60	U	15.00	D
6587	752230	2083299	Unit 1	8.70	D	2.50	U	2.50	U	2.50	U	16.00	D
6687	752150	2083325	Unit 1	7.40	D	1.22	U	<0.5	U	1.43	U	8.10	D
6687	752150	2083325	Unit 1	7.64	U	2.50	U	2.50	U	2.50	U	8.38	U
B206289	752253	2083564	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208089	751143	2085876	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	0.56	U
B208089	751143	2085876	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208189	751138	2085885	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208189	751138	2085885	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208289	751739	2086289	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208289	751739	2086289	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208689	751728	2085250	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B208689	751728	2085250	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B210489	751802	2085513	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B210489	751802	2085513	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B210489	751802	2085513	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
B210489	751802	2085513	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207389	750195	2084468	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207389	750195	2084468	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207689	750398	2085318	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207689	750398	2085318	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207989	750671	2085330	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P207989	750671	2085330	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P208889	751086	2085249	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P208889	751086	2085249	Unit 3	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P208989	751044	2084839	Unit 2	<0.5	U	<0.5	U	<0.5	U	1.16	U	<0.5	U
P208989	751044	2084839	Unit 2	<0.5	U	<0.5	U	<0.5	U	1.20	U	<0.5	U
P209089	750566	2084910	Unit 2	<0.5	U	<0.5	U	<0.5	U	0.56	U	<0.5	U
P209089	750566	2084910	Unit 2	<0.5	U	<0.5	U	<0.5	U	0.56	U	<0.5	U
P209189	750762	2084309	Unit 2	1.30	U	0.73	U	1.88	U	5.07	U	7.80	U
P209189	750762	2084309	Unit 2	1.30	U	0.73	U	1.90	U	5.10	U	7.81	U
P209389	750864	2084130	Unit 2	21.90	D	5.00	U	5.00	U	2.07	U	1.66	U
P209389	750864	2084130	Unit 2	43.77	E	8.61	E	6.49	E	5.00	E	5.00	E
P209389	750864	2084130	Unit 2	44.80	D	6.89	D	4.78	D	2.12	U	1.10	U

RCRA Well ID	Northing Survey Coordinate ⁽²⁾	Easting Survey Coordinate ⁽²⁾	Completion Zone	1,1-Dichloroethylene Levels (ug/L)	Qual Code	CarbonTetrachloride Levels (ug/L)	Qual Code	Chloroform Levels (ug/L)	Qual Code	Tetrachloroethylene Levels (ug/L)	Qual Code	Trichloroethylene Levels (ug/L)	Qual Code
P209389	750864	2084130	Unit 2	49.60	E	7.92		5.00	U	5.00	U	5.00	U
P209489	750991	2084634	Unit 2	0.57		31.80	D	11.70	D	4.70	D	40.30	D
P209489	750991	2084634	Unit 2	5.00	U	63.90	E	23.73	E	5.00	U	75.79	E
P209489	750991	2084634	Unit 2	<0.5	U	54.00	D	17.50	D	12.50	U	62.75	D
P209489	750991	2084634	Unit 2	12.50	U	61.39	E	19.41	E	4.12	U	70.01	E
P209589	751071	2085286	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P209689	750533	2085514	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P209689	750533	2085514	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P209789	750579	2085481	Unit 1	<0.5	U	<0.5	U	<0.5	U	1.54	U	1.02	U
P209889	751194	2084984	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P210089	751564	2084639	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P210089	751564	2084639	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P210189	750752	2084411	Unit 2	50.00	U	399.67	U	130.00	U	50.00	U	2174.00	DE
P210189	750752	2084411	Unit 2	50.00	U	400.00	E	133.57	E	50.00	U	2200.00	DE
P210189	750752	2084411	Unit 2	7.17		4665.00	DE	160.00	D	9.18	D	88.00	E
P210189	750752	2084411	Unit 2	7.20		4700.00	DE	162.00	D	9.20	D	88.19	E
P213689	749460	2083736	Unit 1	<0.5	U	<0.5	U	<0.5	U	0.60	U	<0.5	U
P213689	749460	2083736	Unit 1	<0.5	U	<0.5	U	<0.5	U	0.60	U	<0.5	U
P215789	749470	2083430	Unit 1	81.10	E	<0.5	U	<0.5	U	11.18	U	1467.00	D
P215789	749470	2083430	Unit 1	81.20	D	50.00	U	50.00	U	50.00	U	232.66	U
P219189	751222	2084010	Unit 1	21.00		<0.3	U	0.90	B	<0.2	U	<0.2	U
P219189	751222	2084010	Unit 1	21.00		<0.3	U	0.90	U	<0.2	U	<0.2	U
P219489	750415	2085651	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P219489	750415	2085651	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P219589	750268	2085536	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P219589	750268	2085536	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
P314089	749461	2083653	Unit 1	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
01391	749402	2085226	Unit 1	1.00	U	2.00	U	1.00	U	1.00	U	3.00	U
01491	749430	2085474	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
01791	749504	2086018	Unit 2	<0.2	U	<0.3	U	<0.2	U	6.00	U	<0.2	U
01891	749438	2086023	Unit 2	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
1991	749476	2086734	Unit 2	1.62	U	64.38	E	40.06	E	137.00	E	50.65	E
1991	749476	2086734	Unit 2	25.00	U	790.00		40.35		82.24	E	55.00	E
1991	749476	2086734	Unit 2	1.76		217.66		43.29	E	101.10	E	44.75	E
1991	749476	2086734	Unit 2	12.50	U	674.50	DE	43.75	D	119.50	D	48.80	D
1991	749476	2086734	Unit 2	25.00	U	714.50	D	47.05	D	124.00	D	54.24	E
2291	749880	2086139	Unit 2	50.00	U	1.50	U	3.97	E	150.95	E	178.15	E
2291	749880	2086139	Unit 2	6.93	U	50.00	U	50.00	D	1981.00	D	309.00	D
02491	749949	2086432	Unit 2	<0.2	U	<0.3	U	<0.2	U	15.00	U	<0.2	U
11891	750033	2086999	Unit 2	3.42		182.66	E	16.10	E	105.30	E	628.00	D

RCRA Well ID	Northing Survey Coordinate ⁽²⁾	Easting Survey Coordinate ⁽²⁾	Completion Zone	1,1-Dichloroethylene Levels (ug/L)	Qual Code	CarbonTetrachloride Levels (ug/L)	Qual Code	Chloroform Levels (ug/L)	Qual Code	Tetrachloroethylene Levels (ug/L)	Qual Code	Trichloroethylene Levels (ug/L)	Qual Code
11891	750033	2086999	Unit 2	50.00	U	505.00	D	50.00	U	254.00	D	64.37	E
12191	749774	2086949	Unit 2	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
12191	749774	2086949	Unit 2	20.00	U	160.00	U	5.00	J	250.00	J	29.00	U
12191	749774	2086949	Unit 2	20.00	U	170.00	D	5.00	DJ	270.00	D	32.00	D
12191	749774	2086949	Unit 2	3.00	J	200.00	E	6.00	J	320.00	E	37.00	U
46692	749554	2087077	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	<0.5	U
46792	749538	2087080	Unit 2	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
46892	749524	2087087	Unit 3	<0.2	U	<0.3	U	<0.2	U	<0.2	U	<0.2	U
75992	750290	2086628	Unit 1	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
76292	750769	2085681	Unit 2	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
76292	750769	2085681	Unit 2	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
77492	751246	2083508	Unit 1	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
77492	751246	2083508	Unit 1	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
5393	750549	2085223	Unit 2	10.00	U	10.00	U	10.00	U	10.00	U	10.00	U
23293	749823	2086846	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	1.10	U
23293	749823	2086846	Unit 2	<0.5	U	<0.5	U	<0.5	U	<0.5	U	1.13	U

FOOTNOTES

*Note The majority of the data were not validated at the time this report was prepared

(1) Bold values exceed the MCLs listed in Table 2

(2) State Plane Coordinate System

Qualifier Codes:

D = Compounds identified using dilution factor

E = Concentration reported exceeded calibration range

J = Estimated value reported value less than sample quantitation limit

U = Compound was not detected

Existing Collection System (Interceptor Trench System)

The interceptor trench system (ITS) is located on the hillside north of the SEPs and downslope from the seep line. The ITS was originally designed to collect contaminated ground water from the unconsolidated materials and thus help protect the water quality in North Walnut Creek.

In order to collect all ground water from the unconsolidated materials, the ITS would have to be constructed at the base of the unconsolidated materials with sufficient hydraulic capacity to convey all intercepted ground water. However, the ITS is not keyed into bedrock along its entire length. Effectiveness evaluations performed on the ITS indicate that where the ITS is keyed into bedrock, it is effective in collecting ground water flowing in the unconsolidated/alluvial/colluvial aquifer. The ITS was designed to intercept ground water from a zone approximately 1,760 feet in length oriented perpendicular to the ground water flow path. The effectiveness evaluation results indicated, however, that the ITS is only capable of dewatering approximately 1,400 feet of its total length. The easternmost 230 feet of the ITS are not keyed into bedrock and therefore cannot completely capture or de-saturate this portion of the unconsolidated alluvial aquifer. Therefore, the ITS is only approximately 80% effective from this perspective. In addition to this, questions remain regarding the mechanical integrity of the ITS, including clogged or broken pipes within the subsurface system. Estimates provided in the effectiveness evaluation indicate that the mean flow rate collected from the ITS is 6 gallons per minute or approximately 3,000,000 gallons per year (EG&G, 1994b).

Ground Water Treatment Capacity at Rocky Flats Plant

Since April 15, 1993, flow from the ITS has been routed to the temporary modular storage tanks (TMSTs) and transferred to either the flash evaporators in Building 910, or to the Building 374 process waste treatment system. There are three TMSTs north of the ITS. Each tank has a holding capacity of 500,000 gallons (EG&G, 1994b).

In addition to the Building 374 process waste treatment system, two other wastewater treatment systems are currently available at the RFETS. These systems were originally designed to treat various sources throughout the RFETS. Excess capacity is available at these facilities, and could potentially be used to treat water from other sources. Each of the three wastewater treatment systems is described briefly below.

The OU1 Building 891 Facility is designed to remove VOCs, SVOCs, uranium, heavy metals and hardness. The plant consists of ultraviolet/hydrogen peroxide treatment, equalization, a series of ion exchange columns, a degassing unit, and

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APPENDIX E

treated effluent storage This system is not currently capable of treating influent streams containing free product or high concentrations of suspended solids Also, requirements for pH adjustment may not be compatible with this system Excess treatment capacity of approximately 27 gpm is currently available at the OU1 Building 891 Facility

The Operable Unit 2 water treatment system, also known as the field treatability unit (FTU), is designed to treat water from three surface water sources The FTU is designed to remove settleable solids, dissolved and particulate radionuclides and metals, and VOCs The system consists of influent equalization, chemical treatment, crossflow membrane microfiltration, and granular activated carbon adsorption processes The chemical treatment and microfiltration processes produce sludge which is dewatered in a plate and frame filter press for disposal This system is not currently capable of treating nitrates, free product, or amphoteric metals (e g aluminum, selenium, and zinc) Space for expansion of the existing processes or addition of new processes is reportedly limited at the site Currently, approximately 55 gpm of treatment capacity is available at the FTU, with only 1-2 gpm of capacity being currently used

The Building 374 process waste treatment system is designed to treat a variety of radionuclide and metal bearing waste water streams The system consists of three-stage chemical treatment with precipitation and phase separation provided at each stage, followed by evaporation Sludge from the chemical treatment processes and salt from the evaporation process and solidified prior to disposal This system is not currently capable of treating process streams containing organics or nitrates This plant has been in operation for approximately 15 years, and is reported to require modifications to enhance system reliability and operability It is unknown if the planned modifications will include processes to treat additional constituents (i e , nitrates and organics) The treatment capacity of the Building 374 process waste treatment system is approximately 19 gpm It is unknown what portion of this capacity is currently being utilized

Geophysics Protocol

For both the p and s wave surveys the geophone spacing was five feet, using 14-Hertz vertical geophones for the p-wave and transversely oriented, 28-Hertz horizontal geophones for the s-wave. Six source points were collected for each geophone spread. The data were recorded with a Geometrics Strataview R-48, 48-channel seismograph, yielding a spread length of 235 feet. An overlap of two geophones was used between spreads to improve the continuity of the interpretation along each line. The energy source for the p-wave survey was an Airless Jackhammer which uses a sliding rod mechanism to strike a horizontal integral plate. For the s-wave source a device was used which anchors vertical plates into the ground with a series of spikes. These plates were struck with a conventional sledgehammer to generate transversely polarized shear waves. An equal number of blows were struck on each side of the shear wave plate assembly and were recorded using the corresponding polarity setting on the seismograph. Station surface elevations, which are critical to accurate assignment of interface elevations, were surveyed by conventional techniques by Rocky Flats personnel.

Following acquisition, the data were interpreted using the Oyo program SEISREFA to calculate depths to the interfaces between the various layers. The well data near the lines were used to constrain the seismic interpretation. A more detailed description of the acquisition parameters and interpretation procedures used in this survey can be found in "Geophysical Report, Solar Evaporation Ponds Operable UNIT No. 4, Phase II RFI/RI, May 31, 1995 (EG&G, 1995).

Seismic data acquired during the Phase I field investigations was re-interpreted in order to achieve a full integrated data set for mapping the top of Unit 2. The data were interpreted using the Interpex programs Firstpix and Gremix, generating cross-sections and digital depth files. Borehole information from wells near the seismic lines was used to constrain the interpretation.

The topsoil has an average P-wave velocity of 615 feet per second (fps) and an average shear wave velocity of 250 fps. The alluvium has an average p-wave velocity of 1400 fps and an average shear wave velocity of 590 fps. The weathered bedrock has an average p-wave velocity of 3000 fps and an average shear wave velocity of 910 fps. The water table has an average p-wave velocity of 6100 fps. The unweathered bedrock has an average shear wave velocity of 1750 fps.

Interpretation of the Phase II seismic data resulted in the generation of cross-sections and digital files of the depths to the interpreted interfaces. For the sake of brevity, these cross-sections are not reproduced here, but can be found in EG&G (1995). From these cross-sections, relative low areas in the upper surface of Unit

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APPENDIX F

3 and Unit 2 which were noted in a similar position from line to line across the area to form a linear trend were considered to represent paleochannels

The end result of the interpretation process is a depth cross-section for each of the lines and digital data files of these depths. Water table information was not incorporated into any maps since the Phase I data were acquired during May of 1993 and the Phase II data were gathered during February and March of 1995. For water level maps the data used to generate the maps should be gathered contemporaneously. The top of Unit 2 from the Phase I data was integrated with the corresponding interface data from the Phase II interpretation and the boring log data to produce a structure contour map.

Preferential flow pathways within the consolidated portion of the lithologic section at OU4 are generally formed by zones of fracturing within the upper portion of the bedrock or by paleochannels in the unweathered bedrock. The most highly fractured zones of the bedrock also tend to correspond with the location of the paleochannels. Hence by identifying the paleochannels within the upper surface of Unit 3, the most probable migration pathways can be identified.

25

ENTRY SEPARATOR

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 1:

**Study Area: OU4 and Adjacent Areas
Well Piezometer, Geoprobe and
Seismic Line Locations**

Map ID: Figure 1

November 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 2:

**Isopach of Unconsolidated Deposits
Alluvium, Colluvium, and Fill**

Map ID: Figure 2

November 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 4:

**Geologic Cross Section A – A'
Depicting September 1994
and May/June 1995 Water Level Data**

Map ID: Figure 4

November 4, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 5:

**Geologic Cross Section B – B'
Depicting September 1994
and May/June 1995 Water Level Data**

Map ID: Figure 5

November 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 6:

**Geologic Cross Section C – C'
Depicting September 1994
and May/June 1995 Water Level Data**

Map ID: Figure 6

November 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 7:

**Groundwater Level Elevation Map
Upper Hydrostatigraphic Unit 1
September 1994 Data**

Map ID: Figure 7

December 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

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Figure 8:

**Groundwater Level Elevation Map
Upper Hydrostatigraphic Unit 2
September 1994 Data**

Map ID: Figure 8

November 3, 1995

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
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February 6, 1996

Figure 11:

**Nitrate Concentration Map Upper
Hydrostratigraphic Unit 2**

Map ID: Figure 11

November 6, 1995

CERCLA Administrative Record Document, I101-A-000321

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Final Field Program Report**

February 6, 1996

Figure 12:

**Volatile Organic Compounds
Above MCLs
Upper Hydrostatigraphic Unit 1**

Map ID: Figure 12

November 3, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 13:

**Volatile Organic Compounds
Above MCLs
Upper Hydrostatigraphic Unit 2**

Map ID: Figure 13

November 3, 1995

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 14:

**Representative Radionuclides
Upper Hydrostatigraphic Unit 1
1st Quarter 1995**

Map ID: Figure 14

November 7, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 15:

**Representative Radionuclides
Upper Hydrostatigraphic Unit 2
1st Quarter 1995**

Map ID: Figure 15

November 7, 1995

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 16:

**Phase I and II Seismic Line Locations
and Top of Weathered Bedrock
Contours**

Map ID: Figure 16

November 6, 1995

CERCLA Administrative Record Document, I101-A-000321

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**OU 4 Solar Evaporation Ponds
Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 17:

**Top of Unit 2
(Weathered Bedrock)
Contour Map**

Map ID: Figure 17

April 25, 1995

CERCLA Administrative Record Document, I101-A-000321

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Final Field Program Report**

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Figure 18:

**Top of Unit 3
(Unweathered Bedrock)
Contour Map**

Map ID: Figure 18

April 25, 1995

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**OU 4 Solar Evaporation Ponds
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Final Field Program Report**

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Figure 19:

**Well, Piezometer, Geoprobe and
Seismic Line Locations**

Map ID: Figure 19

November 5, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 20:

**Groundwater Level Elevation Map
Upper Hydrostatigraphic Unit 1
May/June 1995 Data**

Map ID: Figure 20

November 6, 1995

CERCLA Administrative Record Document, I101-A-000321

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Phase II Ground Water Investigation
Final Field Program Report**

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Figure 21:

**Groundwater Level Elevation Map
Upper Hydrostatigraphic Unit 2
May/June 1995 Data**

Map ID: Figure 21

November 6, 1995

CERCLA Administrative Record Document, I101-A-000321

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(Ref: N/A)

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 22:

**Nitrate Concentration Map
Upper Hydrostatigraphic Unit 1
(UHSU1)
2nd Quarter RCRA and Geoprobes**

Map ID: Figure 22

November 7 1995

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Phase II Ground Water Investigation
Final Field Program Report**

February 6, 1996

Figure 23:

**Nitrate Concentration Map
Upper Hydrostatigraphic Unit 2
(UHSU2)
2nd Quarter RCRA and Geoprobes**

Map ID: Figure 23

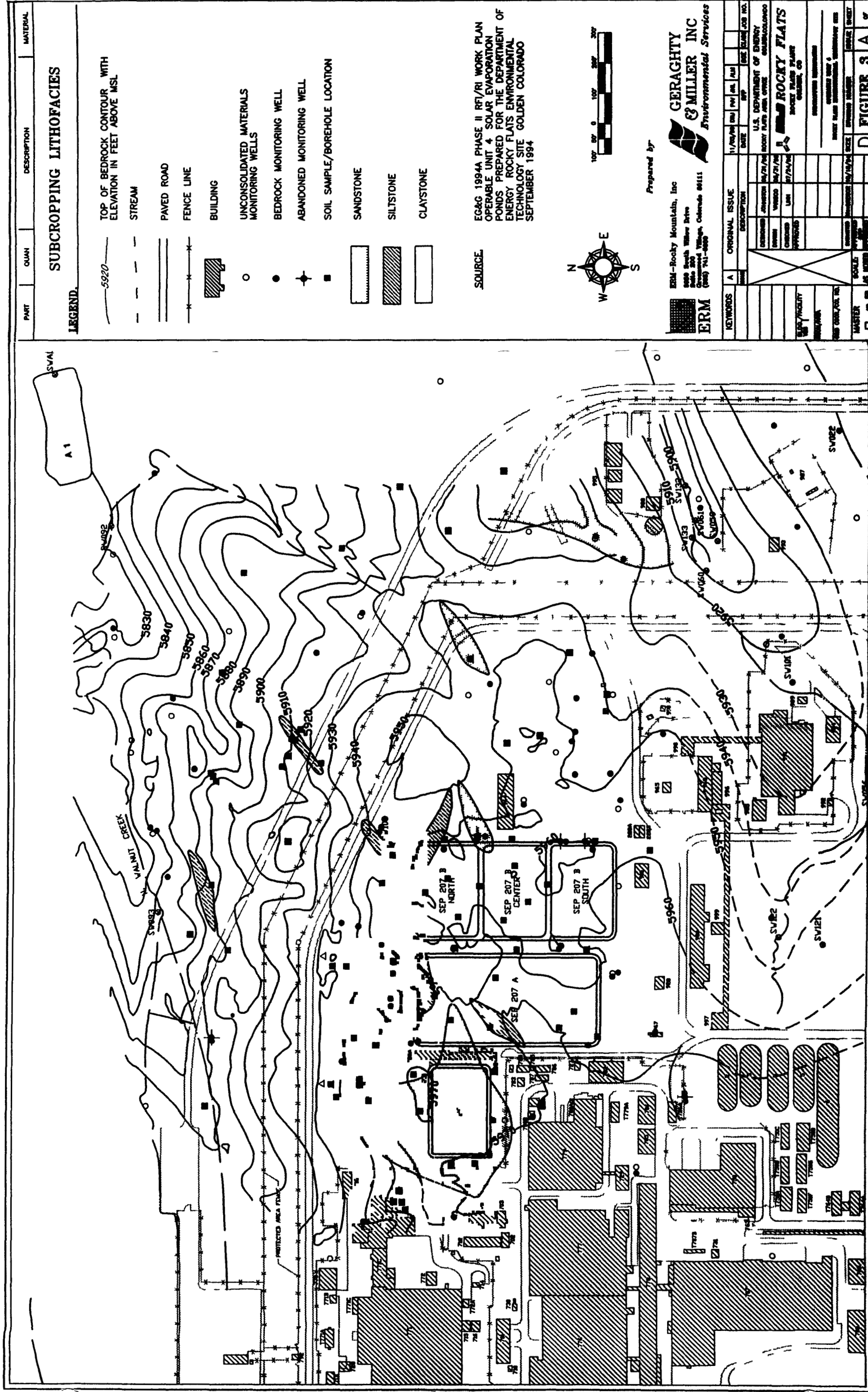
November 7 1995

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pg. 107



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NITRATE CONCENTRATIONS
UNIT 2 (WEATHERED BEDROCK)
1995 DATA

EXTENSION OF AN INTRINSIC CONTRIBUTION
TO THE FORMS AND STRENGTH BASED ON
A MODEL OF THERMAL AND GEOMETRIC
EFFECTS FOR POLYMER FILLS

by J. A. WILSON and S. R. NIELSEN

Department of Chemical Engineering,
University of California, Berkeley, Calif.

- UNIT 2 WITH WITH ID# AND
NUTRIAL CONCENRATION AS NUTROFN
N#
NOT ANALYD
WITH LEVEL BELOW BOTTOM OF SCREEN
AT TIME OF SAMPLING ATTEMPT

NEOTRATOR: A NEW SYSTEM FOR BINDING

5920 TOPOGRAPHIC CONTOUR (FEET ABOVE MSL)

DAVID ROWE

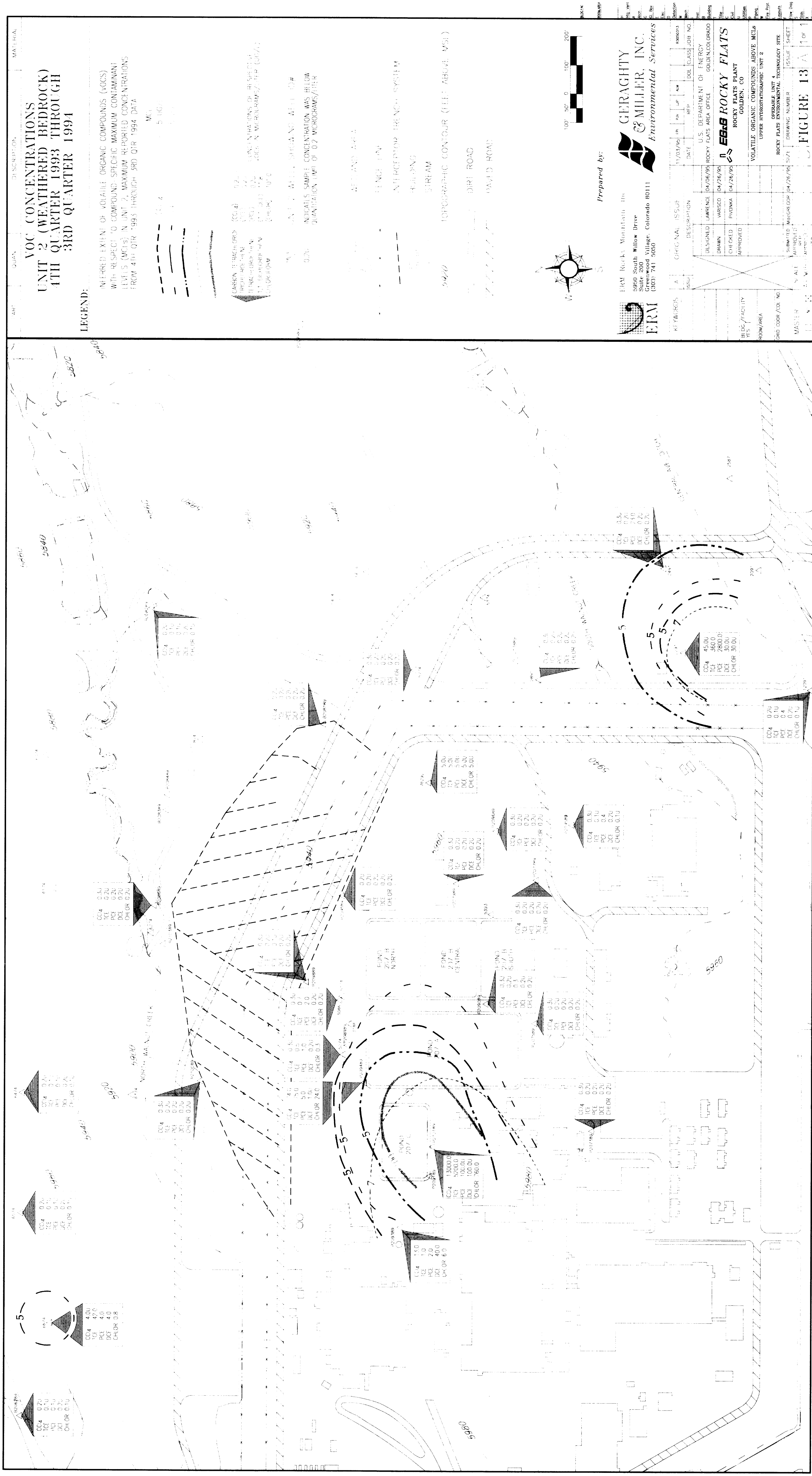


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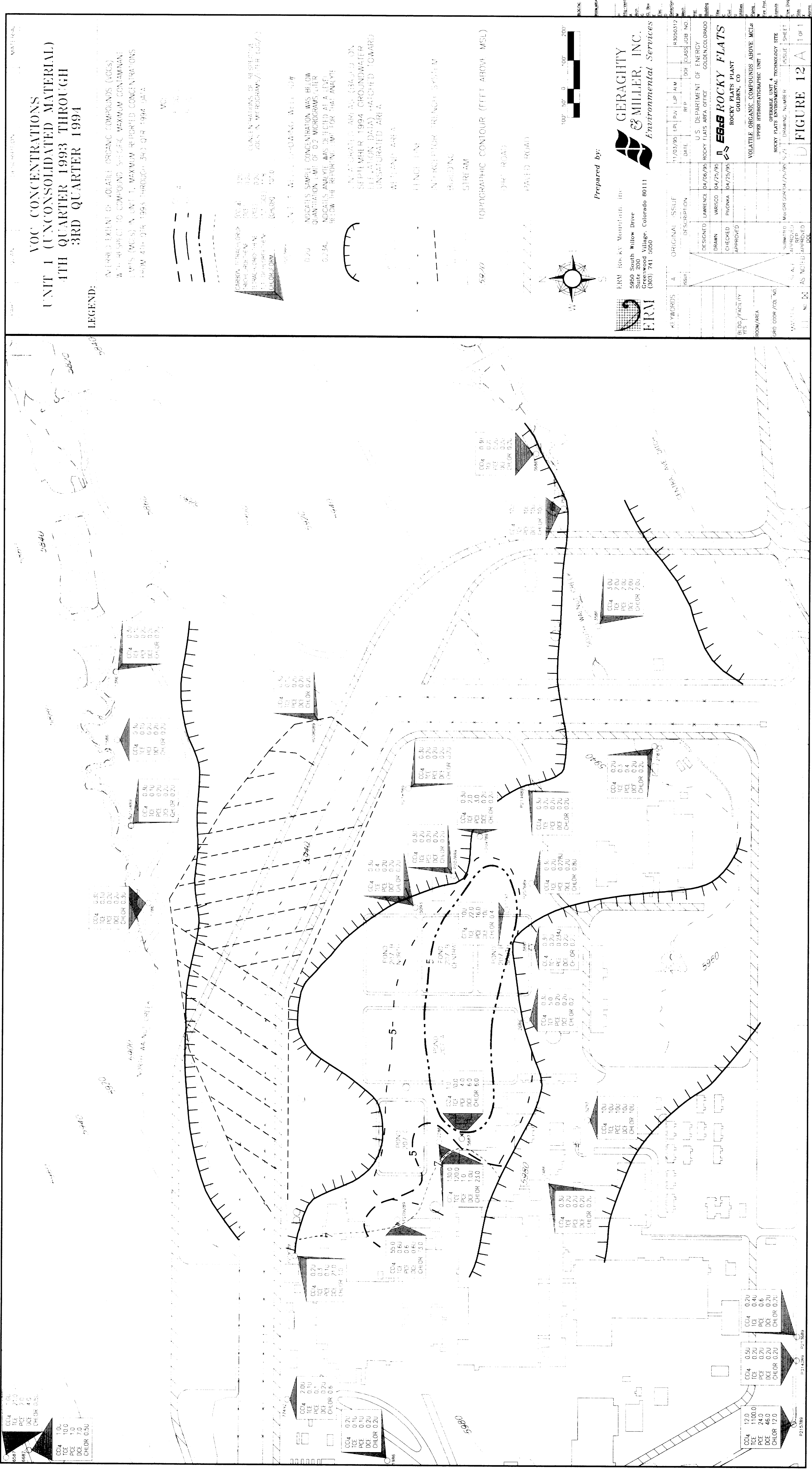
HERALD
HERALD BOOKS, Mountaineers, Inc.
5950 South Willow Drive
Suite 200
Greenwood Village, Colorado 80111
(303) 741-5050

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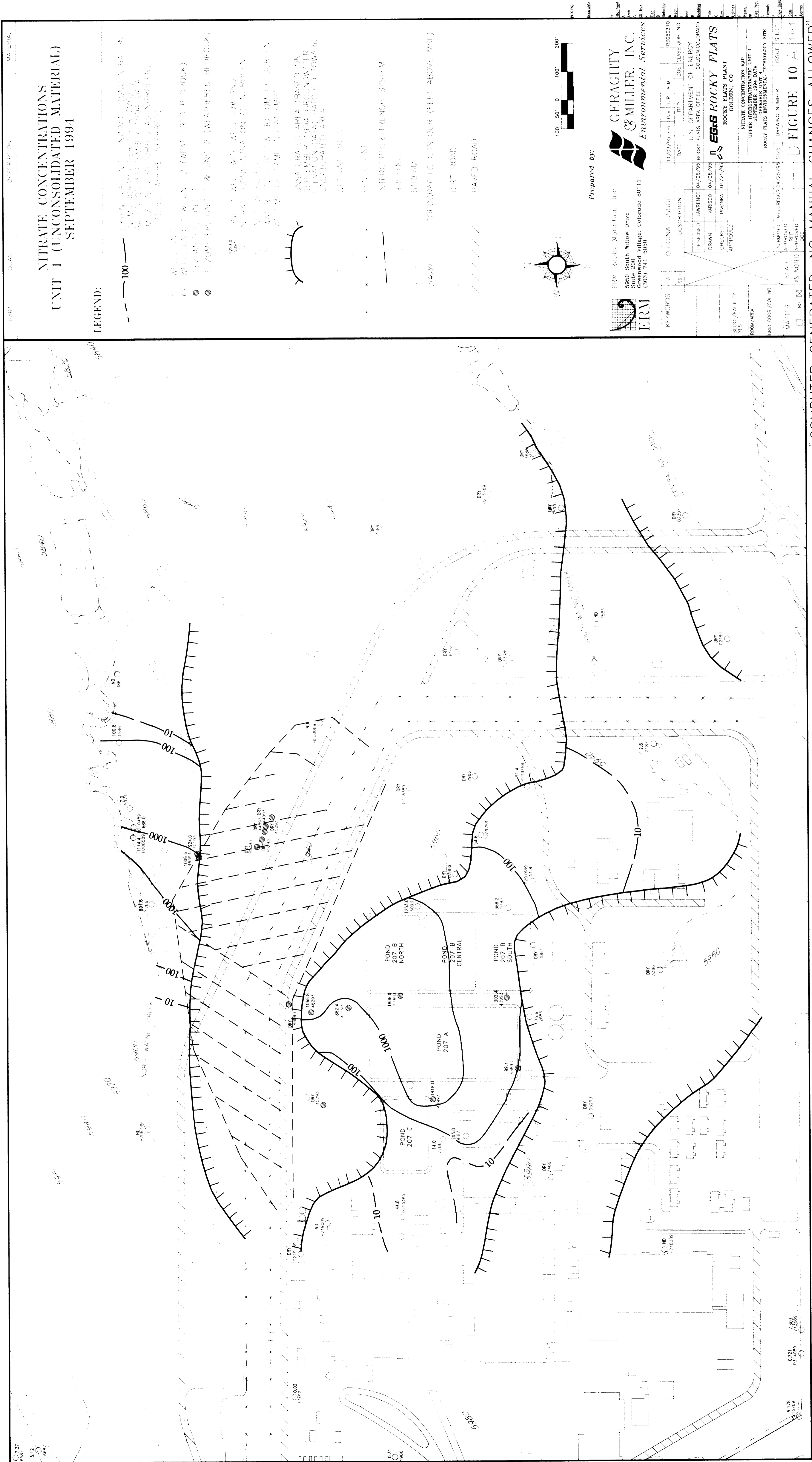
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IL-17-CCC-321 pg. 96



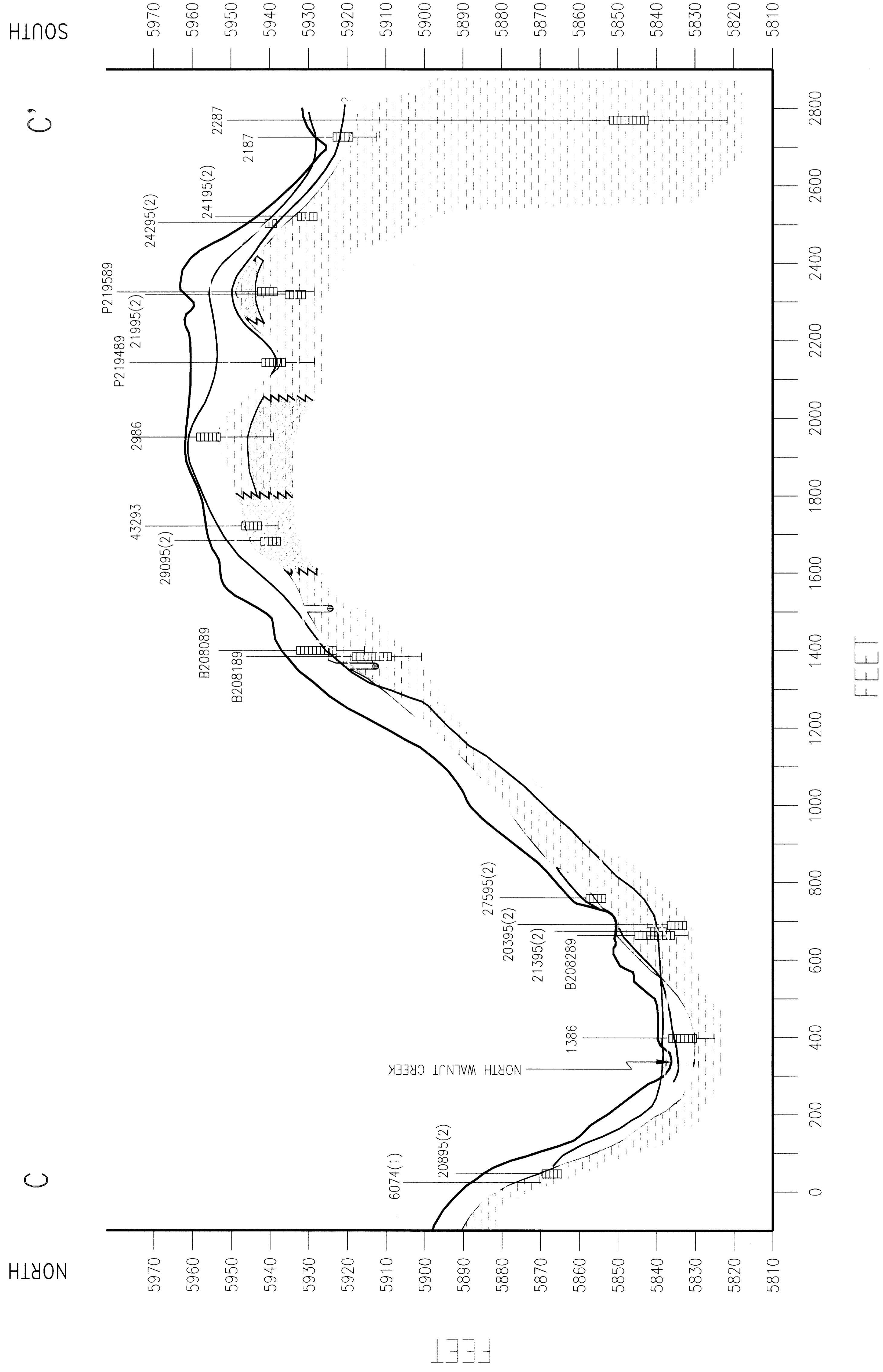
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GEOLOGIC CROSS SECTION C-C'
DEPICTING SEPTEMBER 1994
AND MAY/JUNE 1995 WATER LEVEL DATA

HLNOS

٥

NORTH



LEGEND:



A cross-section diagram of a hill. The hill is represented by a series of connected line segments. The top surface is labeled 'GROUND SURFACE ELEVATION'. Below the ground surface, there are two distinct layers: the upper layer is labeled 'WEATHERED BEDROCK SURFACE ELEVATION' and the lower layer is labeled 'BEDROCK SURFACE ELEVATION'. The diagram shows the relationship between the ground surface, the weathered bedrock surface, and the underlying bedrock surface.

WATER LEVEL ELEVATION:

UNIT 1 (UNCONSOLIDATED MATERIAL)	SEPTEMBER 1994
UNIT 2 (WEATHERED BEDROCK)	SEPTEMBER 1994
UNIT 1 (UNCONSOLIDATED MATERIAL)	MAY/JUNE 1995
UNIT 2 (WEATHERED BEDROCK)	MAY/JUNE 1995

ALLUVIUM/COLLUVIUM/FILL

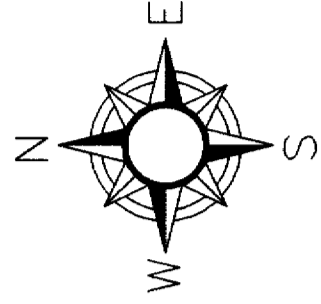
WEATHERED BEDROCK LITHOLOGY

WELL/PIEZOMETER/GEOPROBE WITH ID#
AND SHOWING SCREENED INTERVAL

(1) WELL WITHOUT CONSTRUCTION DATA AVAILABLE

(2) GOEPROBE (LITHOLOGIC INFORMATION UNCONFIRMED)

INTERCEPTOR TRENCH SYSTEM COLLECTION PIPE

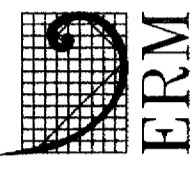


VERTICAL EXAGGERATION: 10X

100' 50' 0 100' 200'

HORIZONTAL SCALE

Prepared by:

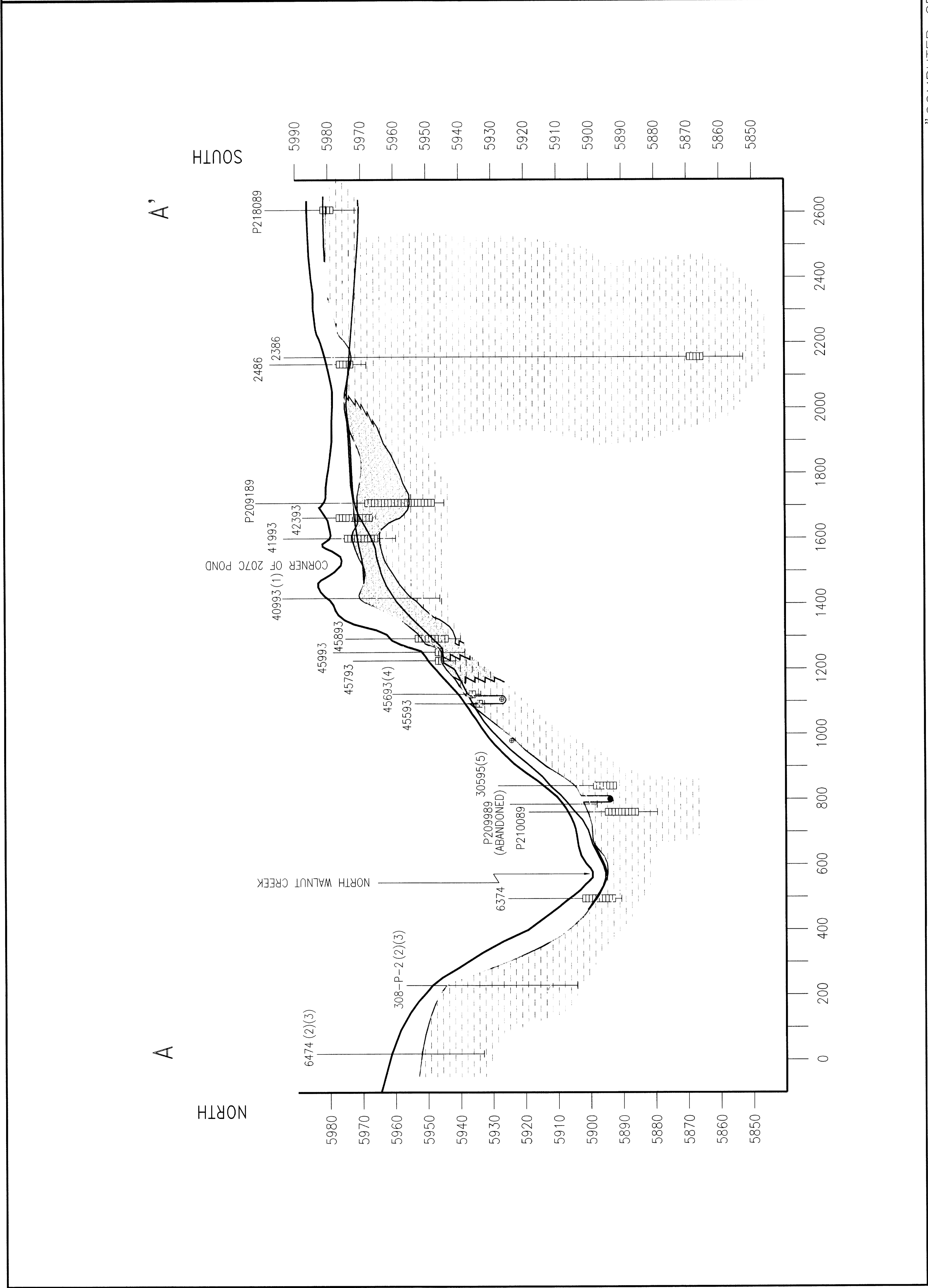


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11



GEOLOGIC CROSS SECTION A-A'
DEPICTING SEPTEMBER 1994
AND MAY/JUNE 1995 WATER LEVEL DATA

LEGEND:

GROUND SURFACE ELEVATION

WEATHERED BEDROCK SURFACE ELEVATION

WATER LEVEL ELEVATION:

UNIT 1 (UNCONSOLIDATED MATERIAL) SEPTEMBER 1994

UNIT 2 (WEATHERED BEDROCK) SEPTEMBER 1994

UNIT 1 (UNCONSOLIDATED MATERIAL) MAY/JUNE 1995

UNIT 2 (WEATHERED BEDROCK) MAY/JUNE 1995

ALLUVIUM/COLLUVIUM/FILL

WEATHERED BEDROCK LITHOLOGY

CLAYSTONE

SILTSTONE

SANDSTONE

GRADATIONAL CONTACT

WELL/PIEZOMETER/GEOPROBE WITH ID# AND SHOWING SCREENED INTERVAL

(1) BOREHOLE WITHOUT WELL

(2) WELL WITHOUT CONSTRUCTION DATA AVAILABLE

(3) WELL WITHOUT AVAILABLE WATER LEVEL DATA (SEPTEMBER, 1994)

(4) NO LITHOLOGIC DATA AVAILABLE

(5) GEOPROBE (LITHOLOGIC INFORMATION UNCONFIRMED)

INTERCEPTOR TRENCH SYSTEM COLLECTION PIPE

INTERCEPTOR TRENCH SYSTEM HEADER PIPE

2386

100' 50' 0 100' 200'

VERTICAL EXAGGERATION: 10X

HORIZONTAL SCALE

N

E

S

W

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U.S. DEPARTMENT OF ENERGY

ROCKY FLATS AREA OFFICE

GOLDEN, COLORADO

U.S. DEPARTMENT OF ENERGY

ROCKY FLATS AREA OFFICE

GOLDEN, CO

KEYWORDS

A

ORIGINAL

ISSUE

DATE

11/04/95

BKN

ENV

LIP

ALM

DOE

CLASS

JOB NO.

R3050304

DESIGNED

NEWLIN

04/06/95

DRAWN

VARISO

04/06/95

CHECKED

PWONKA

04/17/95

APPROVED

BLDG./FACILITY

YES

ROOM/AREA

GRID COOR./COL NO.

SCALE:

MacGREGOR

04/20/95

SIZE

DRAWING NUMBER

ISSUE

SHEET

MASTER

NO

AS NOTED

APPROVED

DOE

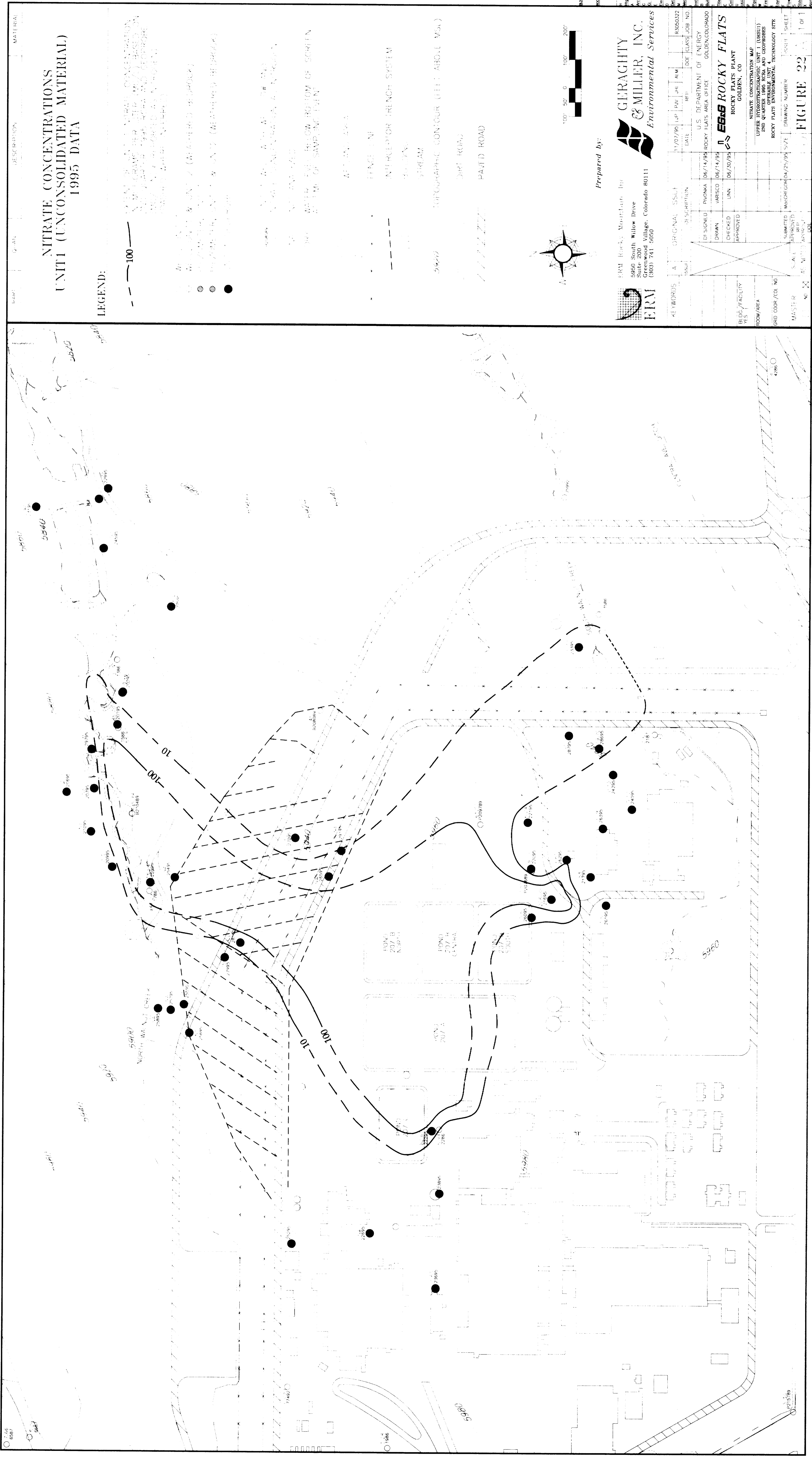
FIGURE 4

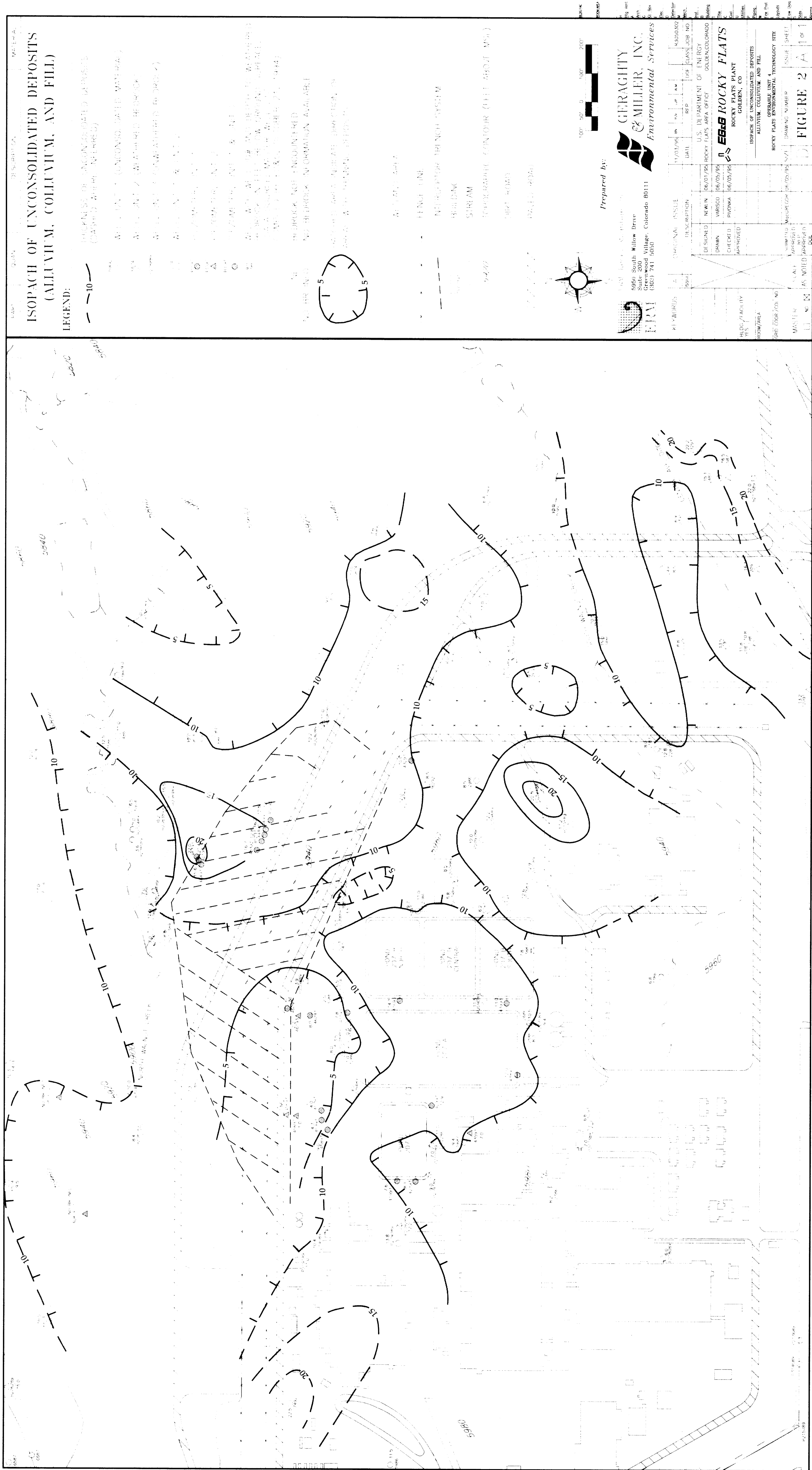
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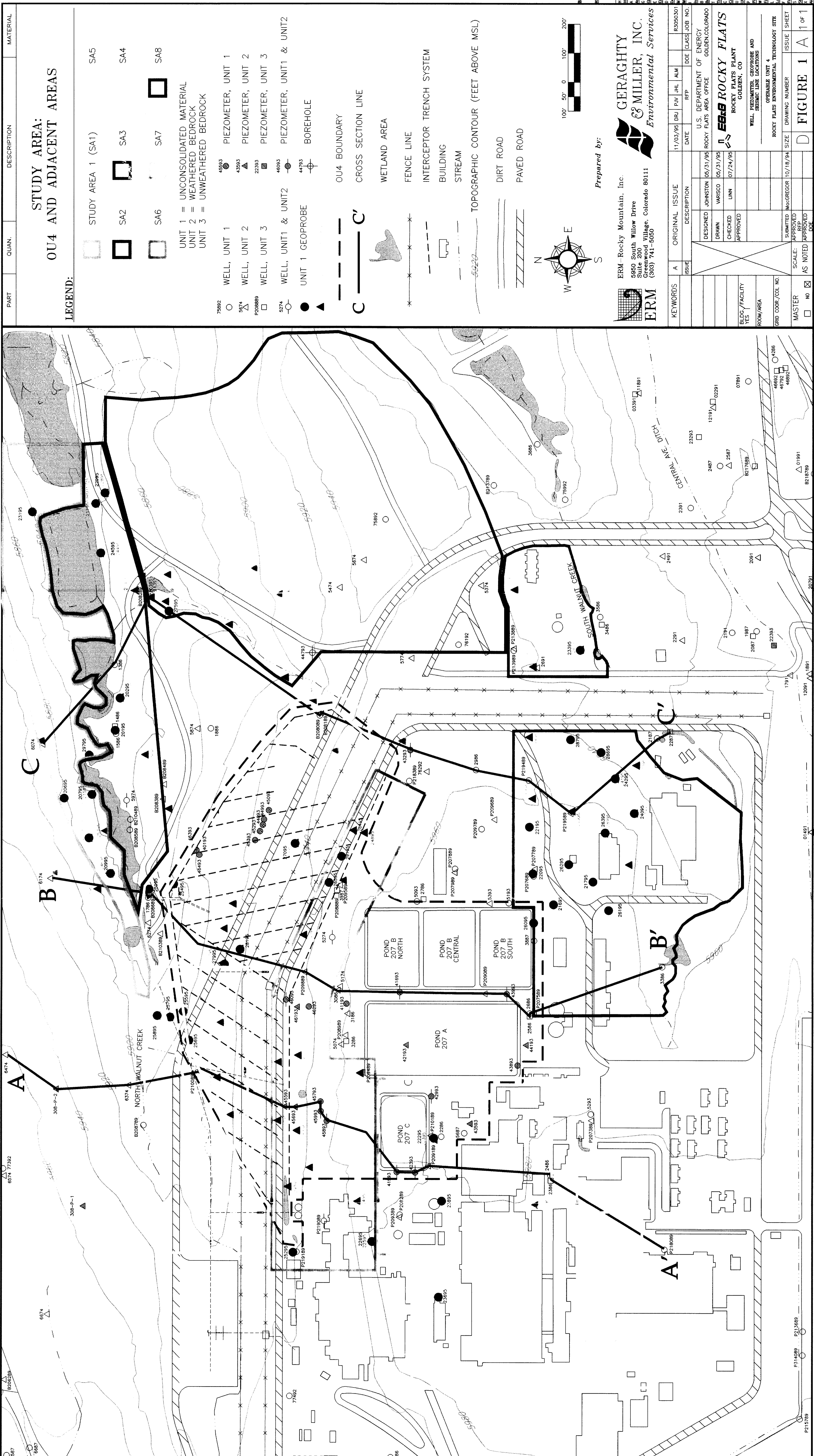
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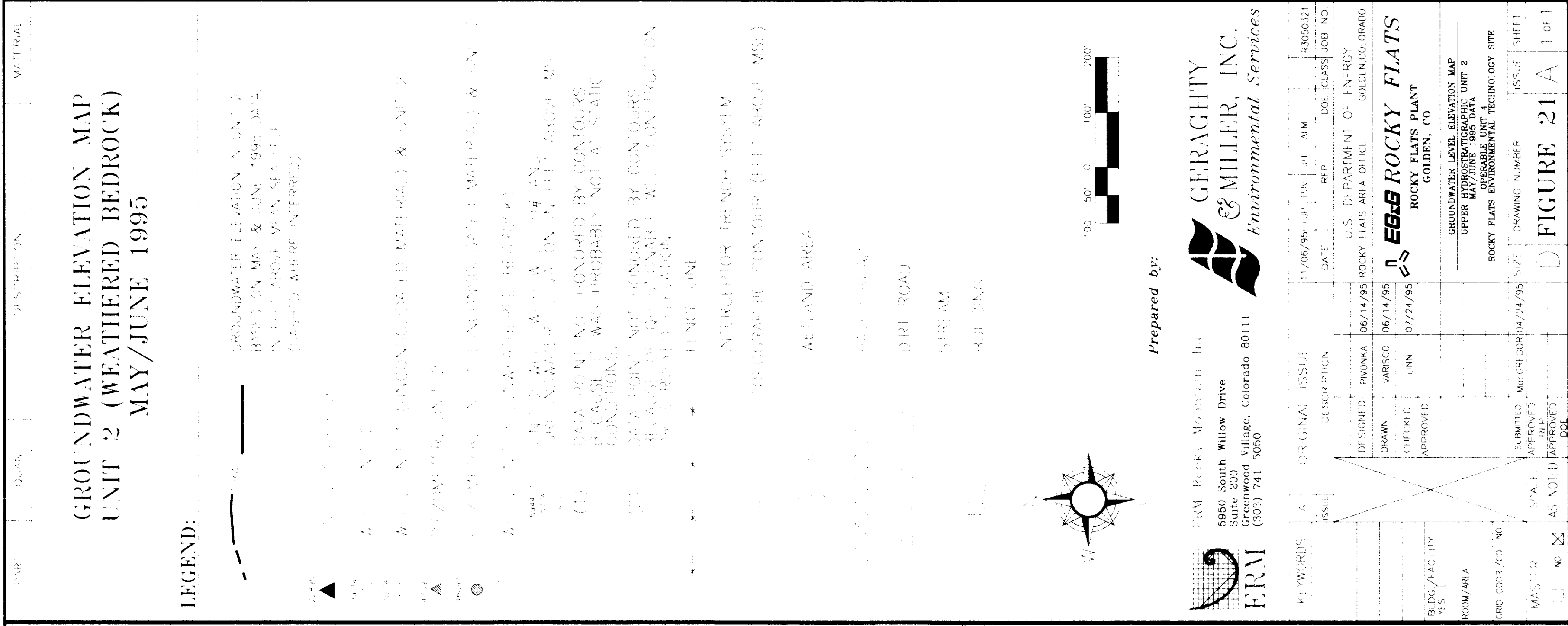
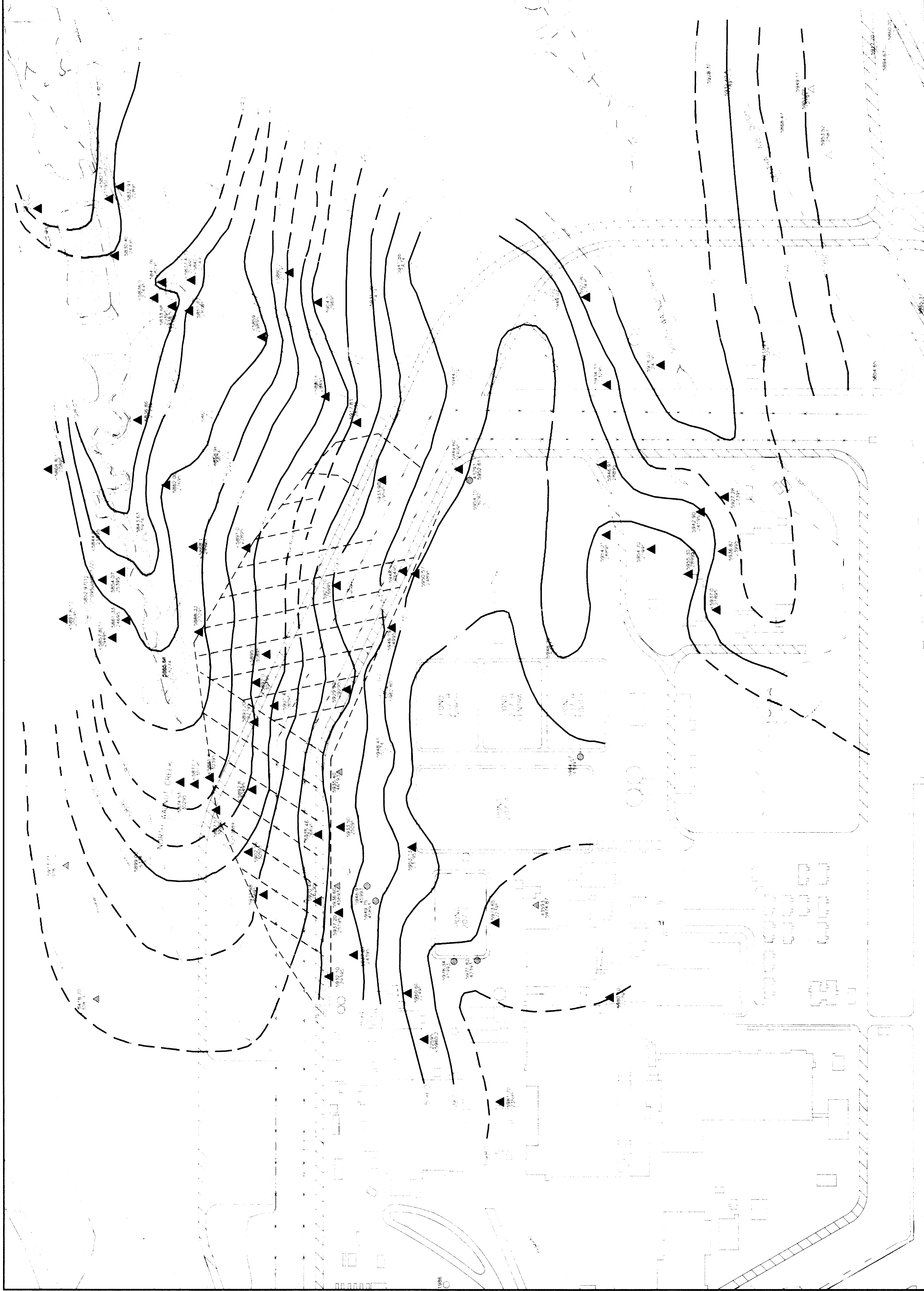
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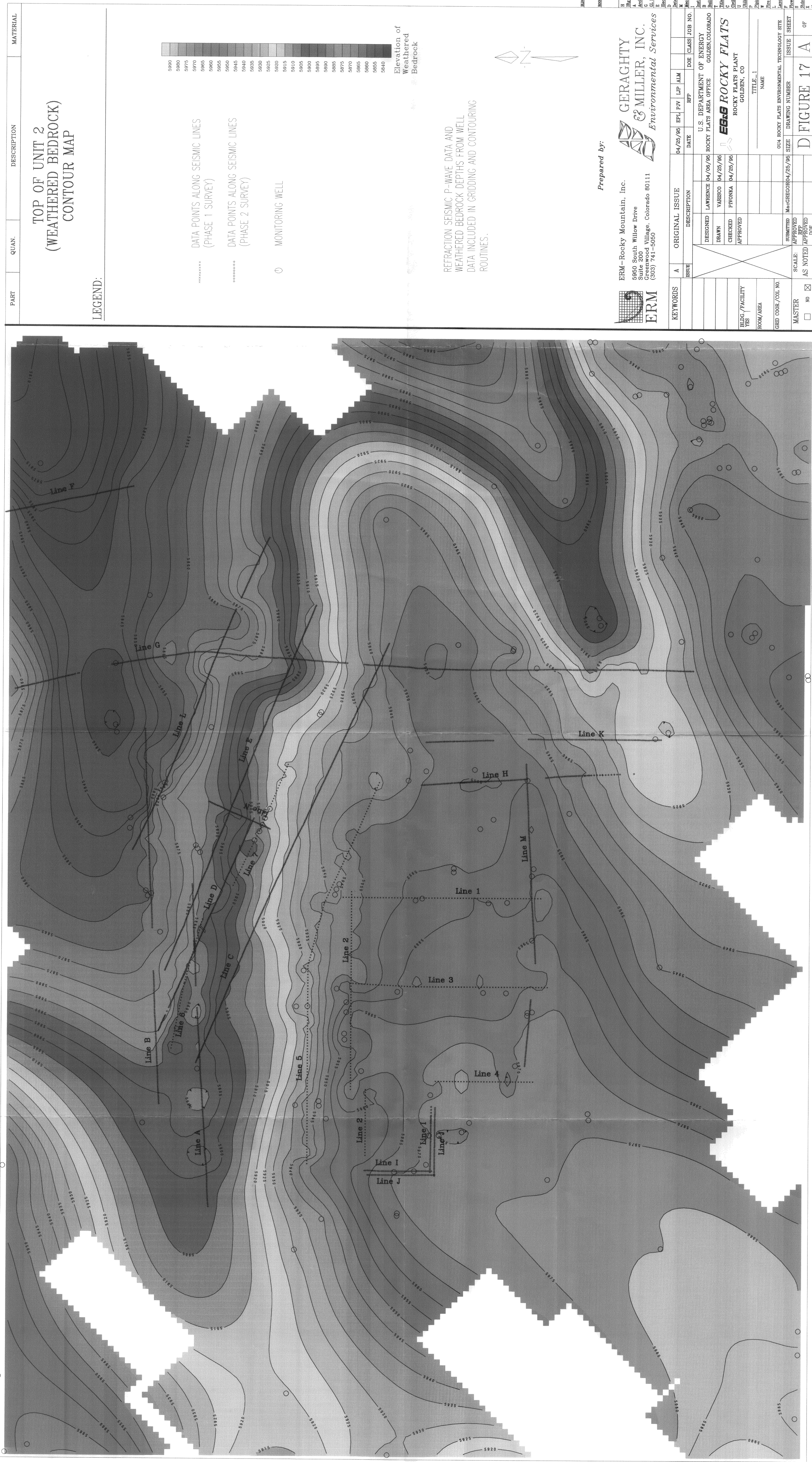


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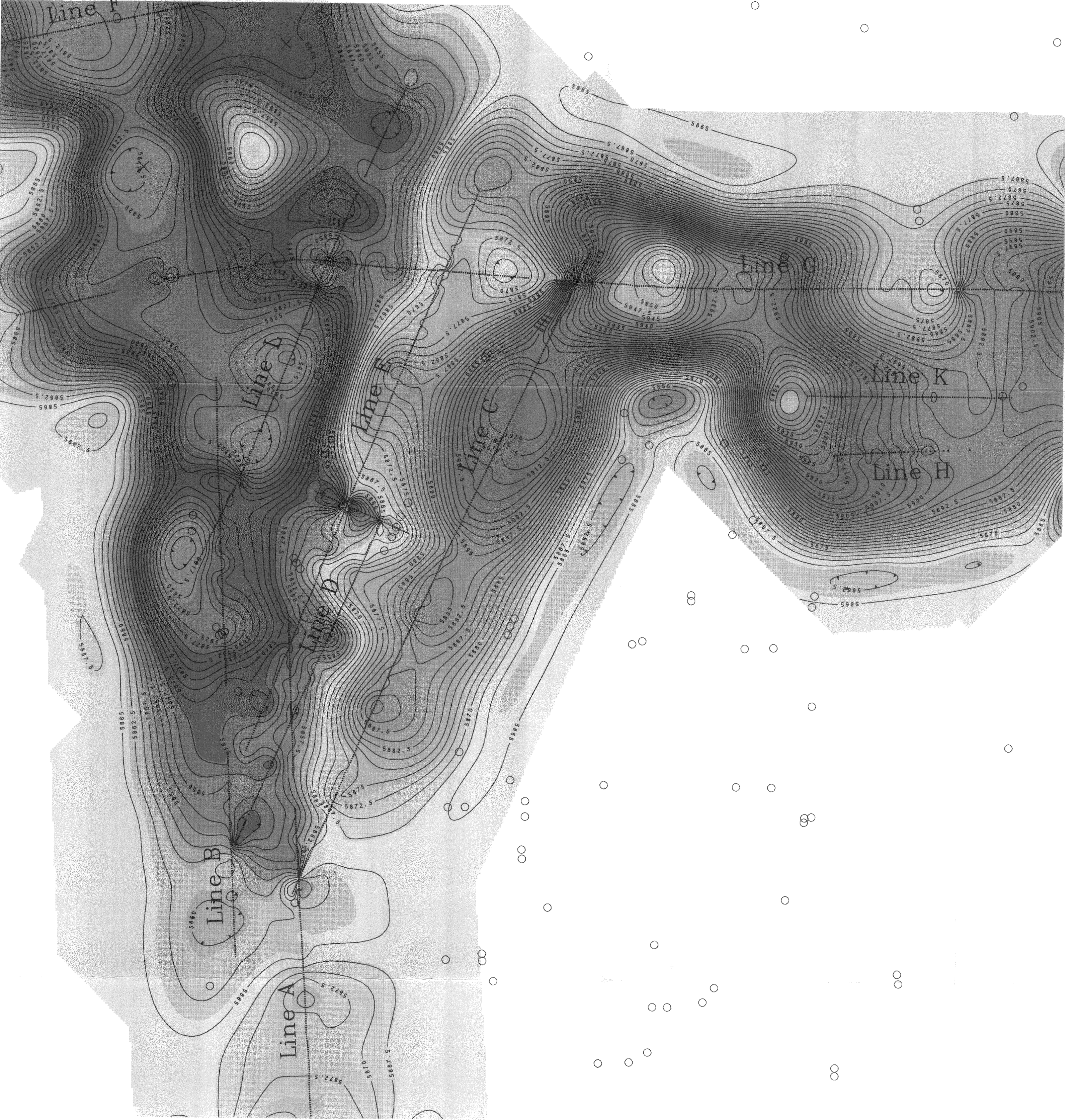


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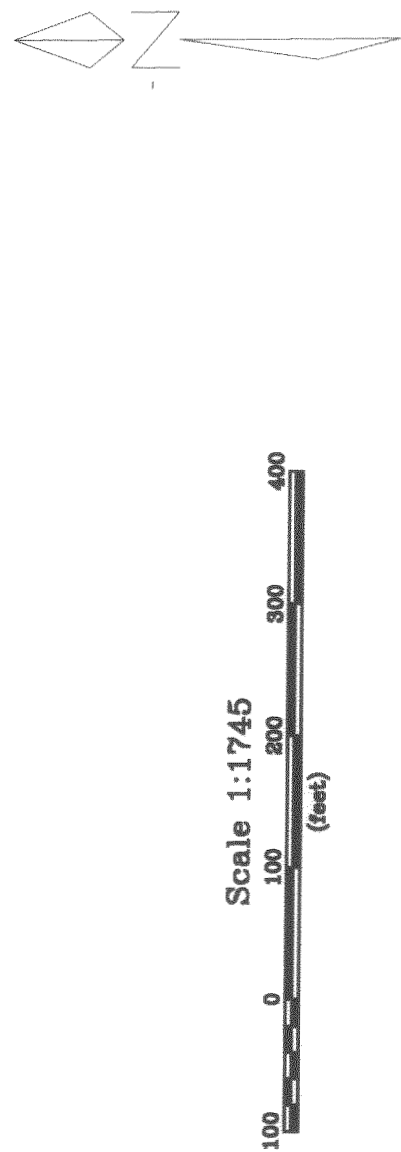
PART	QUAN.	DESCRIPTION	MATERIAL
TOP OF UNIT 3 (UNWEATHERED BEDROCK) CONTOUR MAP			
LEGEND:			

-

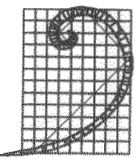
DATA POINTS ALONG SEISMIC LINES
- MONITORING WELL
- ×

SYNTHETIC CONTROL POINT
- GRIDDING AND CONTOURING ROUTINES
CONTAIN ONLY REFRACTION SEISMIC
S-WAVE DATA. WELL LOCATIONS
SHOWN FOR REFERENCE ONLY
- 5954
5936
5923
5914
5905
5897
5890
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5871
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5805
5789
5764

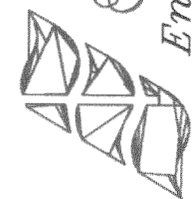
Elevation of
Bedrock



Prepared by:

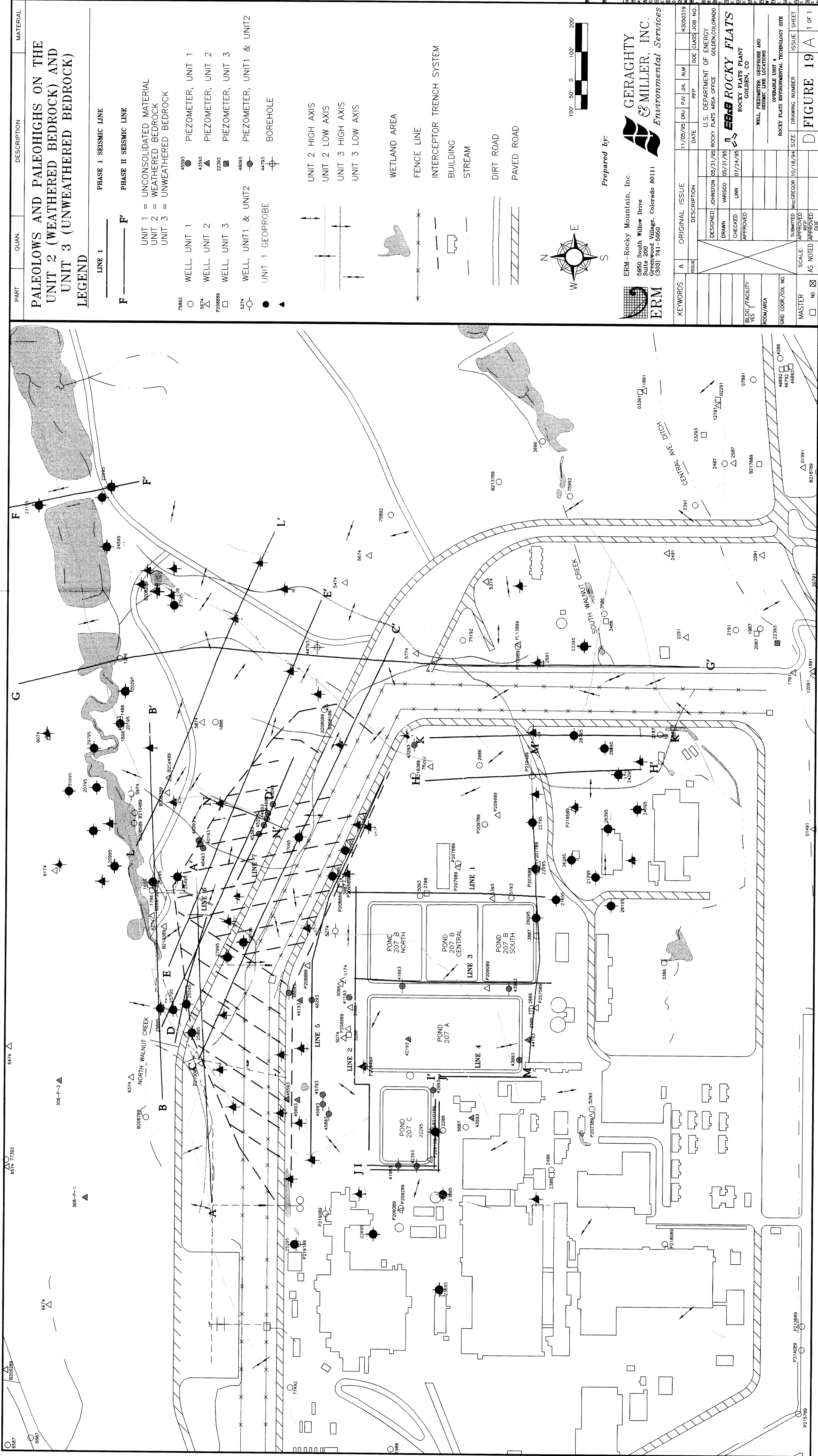


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KEYWORDS		A	ORIGINAL ISSUE		04/25/95	RFP	PV	LIP	ALM	Revision	
ISSUE		DESCRIPTION		DATE	DOE	CLASS	JOB NO.		Title		
		DESIGNED		LAWRENCE	04/06/95	U. S. DEPARTMENT OF ENERGY		GOLDEN, COLORADO		Building	
		DRAWN		VARISCO	04/25/95	ROCKY FLATS AREA OFFICE				Title	
		CHECKED		PYONKA	04/25/95					Title	
		APPROVED								Title	
BLDG./FACILITY										Title	
ROOM/AREA										Title	
GRID COOR./COL. NO.										Title	
MASTER		SCALE:		AS NOTED	APPROVED		DOE		Title		
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THE UNIVERSITY OF CHICAGO

DATE: 06/14/95

SCALE: 1" = 100'

DESCRIPTION: SEISMIC LINE LOCATIONS AND TOP OF WEATHERED BEDROCK CONTOURS

MATERIAL: BEDROCK

PHASE I AND PHASE II SEISMIC LINE LOCATIONS AND TOP OF WEATHERED BEDROCK CONTOURS

LEGEND:

BEDROCK SURFACE CONTOUR BASED ON INTERPRETATION OF LITHOLOGIC DATA FROM WELL LOGS, TOPOGRAPHIC SURFACE, WATER TABLE SURFACES, AND FIELD OBSERVATIONS.
(IN FEET ABOVE MSL)
(DASHED WHERE INTERPRETED)

LINE 1
F

WELL UNIT 1
WELL UNIT 2
WELL UNIT 3
WELL UNIT 4 & UNIT 5

WELL UNIT 6
WELL UNIT 7
WELL UNIT 8
WELL UNIT 9

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WELL UNIT 67
WELL UNIT 68
WELL UNIT 69

GERAGHTY & MILLER, INC.
Environmental Services

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS AREA OFFICE
GOLDEN, COLORADO

ROCKY FLATS PLANT
GOLDEN, CO

PHASE I AND II SEISMIC LINE LOCATIONS
AND TOP OF WEATHERED BEDROCK CONTOURS

UPPER HYDROSTRATIGRAPHIC UNIT 2
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

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FIGURE 16A 1 of 1

COMPUTER GENERATED: NO MANUAL CHANGES ALLOWED

FIGURE 16A 1 of 1

FIGURE 16A 1 of 1

FIGURE 16A 1 of 1

FIGURE 16A 1 of 1

FIGURE 16A 1 of 1

